2012

Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the Western North Atlantic Ocean

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Table of Contents

BACKGROUND

Inter-agency agreements (IA) were established between NOAA National Marine Fisheries Service (NOAA Fisheries Service) and the Bureau of Ocean Energy Management (BOEM) – IA number M10PG00075 – and between NOAA Fisheries Service and the US Navy – IA number NEC-11-009. These two IAs specify that the NOAA Fisheries Service will provide services to BOEM and the US Navy in the form of the Atlantic Marine Assessment Program for Protected Species (AMAPPS) in the US Atlantic Ocean from Maine to the Florida Keys. The NOAA Fisheries Service work is being conducted by the Northeast Fisheries Science Center (NEFSC) and the Southeast Fisheries Science Center (SEFSC). Additional work is being carried out the US Fish and Wildlife Service (USFWS). This is a report of the work conducted by NOAA Fisheries Service during 2012.

AMAPPS is a comprehensive research program to assess the abundance and spatial distribution of marine mammals, sea turtles, and sea birds in US waters of the western North Atlantic Ocean. This program includes collecting data on seasonal vessel and aerial surveys for marine mammals, sea turtles, and sea birds, data on tagging projects, and data on other related projects, in addition to the analyses of these data with the goal to quantify abundance and spatial distribution and to produce spatially explicit density distribution maps. The data collection and analysis efforts are conducted by the NOAA Fisheries Service NEFSC and SEFSC and the USFWS Division of Migratory Birds. AMAPPS is funded by BOEM, NOAA Fisheries Service, USFWS, and the US Navy.

The AMAPPS data will be used to support environmental assessments associated with BOEM and US Navy activities, including anticipated offshore energy exploration projects. These data are being used to improve the assessment of marine mammal stocks as required under the Marine Mammal Protection Act (MMPA); for example, provide data to support updated abundance estimates for US Atlantic oceanic stocks of marine mammals (e.g., Waring *et al.*, 2013). In addition, these data are also being used to support programs that monitor the risk of extinction and recovery of the species detected during the surveys, including those species not already covered under the MMPA.

SUMMARY OF 2012 ACTIVITIES

During 2012 under the AMAPPS initiative, NOAA Fisheries Service conducted field studies to collect cetacean, sea turtle, and seal seasonal distribution and abundance data and studies to collect sea turtle and seal telemetry data (Table 1). In addition, NOAA Fisheries Service continued analyzing past data collected under AMAPPS (Table 2). So far, these projects have resulted in seven published or in review papers (Table 3). A summary of the 2012 projects follows, with more details in the appendices.

<u>Field activities</u>

During spring (March – May) 2012 and fall (September – November) 2012, the NEFSC and SEFSC conducted aerial line-transect abundance surveys using NOAA Twin Otter airplanes targeting marine mammals and sea turtles. The surveys were designed to cover northern Atlantic continental shelf waters, from southeastern Florida to the southern tip of Nova Scotia, Canada, from the coast line out to either the 200 m depth or 2000 m depth contours, depending on the area (Figures 1 and 2; Table 1). These data will be used in developing density/abundance estimates of marine mammals and sea turtles that are at or above the ocean surface within the study area and in developing spatially and temporally explicit density maps that incorporate environmental factors. There were approximately 18,058 km of completed track lines during the spring survey and 18,909 km completed during the fall survey. During the spring of 2012 there were about 489 groups (2532 individuals) of 19 detected cetacean species or species groups; 1414 groups (1578 individuals) of 5 turtle species or species groups; and there were 49 seal groups (53 individuals) that were either harbor or gray seals (Table 4). During the fall of 2012 there were about 389 groups (4376 individuals) of 15 detected cetacean species or species groups; 1844 groups (2110 individuals) of 5 turtle species or species groups and only 6 seals seen (Table 4). During both seasons bottlenose dolphins (*Tursiops truncatus*) were the most commonly seen dolphin and fin whales (*Balaenoptera physalus*) were the most commonly seen large whale. Harbor porpoises (*Phocoena phocoena*), Risso's dolphins (*Grampus griseus*), white-sided dolphins (*Lagenorhynchus acutus*) and right whales (*Eubalaena glacialis*) were more prevalent in the spring as compared to the fall. In contrast, there were more striped dolphins (*Stenella coeruleoalba*), pilot whales (*Globiciphala spp.*) and common dolphins (*Delphinus delphis*) in the fall. In general there were more turtles, of all species, detected in the fall, as compared to the spring. Seals were mostly seen in the ocean in the spring, while only a couple animals were seen in the fall. Details of the surveys can be found in Appendices A (NEFSC) and B (SEFSC). These sightings and effort data will be archived in the NEFSC Oracle database.

The NEFSC, in collaboration with Coonamessett Farm Foundation, Virginia Aquarium and Marine Science Center, and the National Marine Life Center conducted a loggerhead turtle tagging study. The findings from this study will result in dive time correction factors for the proportion of loggerhead turtles that were in the study area but were underwater and therefore, not available to be detected at the surface during the abundance surveys. In addition, these data will provide information on loggerhead turtle habitat use, residence time, behavior, and life history. In June 2012, 32 satellite tags were deployed on immature loggerhead turtles primarily in waters 40 – 80 miles off Delaware through Virginia. Each of the tagged loggerhead turtles were measured and weighed, biopsy samples for genetic analyses were collected, and blood samples were collected to analyze for testosterone levels (to identify sex) and general blood chemistry (for health assessment). As of the end of December 2012, 23 of the 2012 tags were still actively transmitting. As of 4 June 2012, fourteen tags from 2011 have been transmitting for about one year. More details can be found in Appendix C. These satellite tag data are archived in the Northeast Sea Turtle Collaborative Oracle database, maintained by the NEFSC and displayed on their website (http://www.nefsc.noaa.gov/psb/turtles/turtleTracks.html). Photographs and other computerized data are stored on NEFSC servers. Biological samples are stored in freezers at the NEFSC and the NOAA Fisheries Service Southwest Fisheries Science Center.

To estimate the abundance of harbor seals and provide information on their spatial distribution and habitat preferences, NEFSC and a team from 13 other organizations used a practical and statistically valid survey design that involved simultaneously conducting an aerial photogrammetric abundance survey of hauled out seals and an aerial radio-tracking survey to determine the proportion of radio-tagged seals that were at those hauled out sites. The proportion of radio-tagged seals was used to correct for the animals not availability during the abundance survey. Because of the logistic problems encountered in 2011, this project was implemented again in 2012. In 2012, 22 harbor seals were radio-tagged in Chatham Harbor, MA during late-March 2012 and 15 in western Penobscot Bay during mid-April 2012. The aerial survey and radio tracking components were successfully conducted during 27 May – 2 June 2012. Statistical analyses and abundance estimation were completed in February 2013 and reported in the marine mammal stock assessment report which was reviewed at the March 2013 Atlantic Scientific Review Group Meeting. More details on the 2012 project can be found in Appendix D. The computerized data from the tags, photographs and samples are archived in the NEFSC Oracle database. The collected biological samples were sent to several organizations that are analyzing the samples, including Woods Hole Oceanographic Institution and Cornell University.

<u>Analyses</u>

During 2011 and 2012, NEFSC and SEFSC staff analyzed the 2011 shipboard and aerial AMAPPS abundance survey data to estimate the abundance of 19 species of cetaceans. The data were collected using the two independent team data method and were analyzed using the mark-recapture distance sampling with multiple covariates method. Overall, nearly 435,000 individual cetaceans were estimated to be present in the study area which covered the US Atlantic waters within the US EEZ and within the Canadian waters in the lower Bay of Fundy and Gulf of Maine. These estimates have been presented in the 2012 and 2013 MMPA Atlantic Stock Assessment Reports. Details can be found in Appendix E.

During 2012 new standardized passive acoustic hydrophone array systems were built by staff from all of the NMFS science centers. Two of those array systems will be used during the summer 2013 AMAPPS shipboard surveys, one on the NEFSC survey and one on the SEFSC survey. In addition, the passive acoustic data collected on the 2011 Northeast AMAPPS shipboard survey are being used in five ongoing projects: (1) integration of acoustic recordings and visual confirmation of Sowerby's beaked whales (*Mesoplodon bidens*) have resulted in an in-review journal paper documenting this first time event; (2) determination of acoustic detection rates of sperm whales (*Physeter macrocephalus*) to be incorporated into an abundance estimate that will account for not only the animals seen on the survey but also those animals unavailable because they were underwater; (3) identification and extraction of acoustic records from encounters with seven delphinid species that are being used in the development of a whistle classifier called ROCCA; and (4) echolocation clicks of Risso’s dolphins are being characterized and used for comparison with other regions; and (5) documentation of the methods used to acoustically track marine mammals and their consideration for density estimation has resulted in an in-review chapter of a book. Details can be found in Appendix F.

Describing the relationships between the current patterns of density and distribution of marine mammals and seabirds as related to their physical and biological environment is one way to understand not only how environmental habitat characteristics drive/control the distribution and density of these animals, but also a) how to forecast animal density maps to a future time when environmental conditions may have changed, and b) how to discriminate between changes in cetacean populations due to natural environmental variability and changes due to anthropogenic impacts. As an initial exploration into this, hydrographic characteristics of the water column are currently being compared to the plankton distribution patterns that were documented during the

2011 NEFSC AMAPPS shipboard abundance survey. The next step will be to compare these relationships to the marine mammal sea turtle, and seabird distribution patterns. Details on this project can be found in Appendix G.

To estimate the population size of loggerhead turtles (*Caretta caretta*), the data collected during the AMAPPS aerial abundance surveys that covered the US continental shelf waters need to be corrected for the number of animals not in the study area. The objective of this project is to combine skeleto-chronological and stable isotope analyses of annually laid skeletal growth marks (GMs) in juvenile North Atlantic loggerhead sea turtle humeri to refine estimates of the number of young age classes that have not yet entered the habitats along the east coast of the US where the aerial abundance surveys are being conducted. From stranded loggerheads that were collected during 1996 – 2010, a total of 246 humeri from oceanic (n = 22, Azores Islands) and neritic (n = 224, U.S. Atlantic coast) loggerheads were analyzed. It was estimated that the mean oceanic stage was about 12 – 13 yrs, which results in a loggerhead that is about 55.3 cm straight carapace length (SCL). The mean minima were 8 – 10 yrs at 43.9 cm SCL, and mean maxima were 16 – 19 yrs at 67.2 cm SCL. A manuscript describing this study and its findings is currently in review for publication in *Marine Ecology Progress Series*. Details can be found in Appendix H.

Improved estimates of survival rates of oceanic juvenile loggerhead turtles (*Caretta caretta*) will allow better prediction of the recruitment of juveniles from their offshore oceanic habitat to the coastal neritic habitat, which is the region where the AMAPPS aerial surveys have observed and counted turtles. The 2010 AMAPPS funds supplemented Stock Assessment Improvement Plan (SAIP) funds for a tagging project on the Canadian Grand Banks Northeast Distant Region of the Atlantic Ocean. This tagging project resulted in an estimate of the survival rate for this life stage of loggerheads. During 9 – 16 August 2011, 24 juvenile loggerheads captured on the Canadian Grand Banks were outfitted with pop-off archival transmitting tags (PATs). After a year, the tags popped off the animals and then transmit their data. These transmission data were used in a known fate model and resulted in an estimated annual survival rate of 0.89 (with a 95% confidence interval of 0.72 – 0.96). The best model of the data suggested survival was constant across months. Details can be found in Appendix I.

To achieve the AMAPPS objective of quantifying abundance and spatial distribution, a database is needed to store the collected data. The NEFSC had already created an Oracle database for some of the past NEFSC line-transect abundance surveys. During 2012, the abundance survey Oracle database was expanded to be more flexible to allow incorporation of data from disparate sources and in varying formats. The NEFSC and SEFSC shipboard seabird strip-transect and marine mammal line-transect data were added to the database. The environmental data collected by the ship (stored in another Oracle database) have been linked to the AMAPPS abundance survey database to obtain the time specific values of the environmental variables associated with an AMAPPS event. The ability to download the Oracle data was also improved and used to output 2007 seabird data to be used in a community analyses being conducted by a University of Massachusetts student. The disposition and handling of tissue samples collected under AMAPPS have been added to the tissue tracking database. In addition, the satellite-tagged loggerhead turtle and harbor seal photograph metadata and associated counts have been added to the Oracle database. Details can be found in Appendix J.

REFERENCES CITED

Waring GT, Josephson E, Maze-Foley K, Rosel, PE, editors. 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2012. NOAA Tech Memo NMFS NE 223; 419 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

Table 1. General information on the AMAPPS NOAA Fisheries Service field data collection projects that occurred during 2012: the project name, NOAA Fisheries Service principal investigating center, platforms used, dates and general location of the field study, and the appendix within this document where more information on the project can be found.

2012 field collection projects	Platform(s)	Dates in 2012	Location	Appendix
Spring abundance survey NEFSC)	NOAA Twin Otter aircraft	28 Mar – 3 May	Shelf waters north of New Jersey to Nova Scotia	A
Spring abundance survey (SEFSC)	NOAA Twin Otter aircraft	3 Apr – 21 May	Shelf waters from New Jersey to Florida	B
Fall abundance survey (NEFSC)	NOAA Twin Otter aircraft	17 Oct – 16 Nov	Shelf waters north of New Jersey to Nova Scotia	A
Fall abundance survey (SEFSC)	NOAA Twin Otter aircraft	11 Sep – 16 Oct	Shelf waters from New Jersey to Florida	B
Northern sea turtle tagging (NEFSC)	F/Vs Kathy Ann and Ms. Manya	30 May – 4 Jun	40 - 80 miles offshore of Delaware to Virginia	C
Harbor seal tagging (NEFSC)	Small boats	24 - 30 Mar; 12 - 17 Apr	Chatham Harbor, MA; Western Penobscot Bay, ME	D
Harbor seal abundance survey (NEFSC)	NOAA Twin Otter aircraft and USFWS Kodiak aircraft	27 May - 2 Jun	Coastal waters from Cape Elizabeth, ME to eastern Machias Bay, ME	D

Table 2. A brief description of the purpose of the AMAPPS NOAA Fisheries Service analyses projects that occurred during 2012 and the appendix where more information on the project can be found.

2012 analysis projects	Purpose	Appendix
Harbor seal abundance estimate	Use 2012 tagging and aerial photographs to start estimation of harbor seal abundance	D
Marine mammal abundance estimates	Use 2011 AMAPPS shipboard and aerial surveys to estimate abundance of as many species as possible	E
Sowerby's beaked whale acoustics	Description of the acoustic signature of the Sowerby's beaked whale and application to analyses of 2011 AMAPPS acoustic data	F
Acoustic and visual abundance estimate of sperm whales	Use the acoustic and visual detection rates collected in 2011 AMAPPS survey to estimate a more accurate abundance estimate of sperm whales	F
Whistle and echolocation classification	Contribute confirmed acoustic signatures of dolphins to the developing whistle classifier ROCCA; extract acoustic data for analyses of Risso's dolphin echolocation click characteristics	F
Acoustical track marine mammals	Document methods for acoustic tracking marine mammals using hydrophone arrays, and discuss considerations for density estimation	F
Construction of towed hydrophone array	Built a hydrophone array system that will be used on future AMAPPS surveys and is standardized between NOAA Science Centers	F
Comparison of hydrographic, plankton, and marine mammal distribution and abundance patterns	Hydrographic characteristics of the water column are being compared to the plankton distribution patterns that were documented during the 2011 AMAPPS NEFSC shipboard abundance survey	G
Improve loggerhead turtle abundance estimate	Use skeletal growth marks in juvenile North Atlantic loggerhead sea turtle humeri to refine estimates of the number of young age classes that have not yet entered the habitats along the east coast of the US where the AMAPPS aerial abundance surveys are being conducted	H
Improve loggerhead turtle abundance estimate	Improve estimate of survival rates of oceanic juvenile loggerhead turtles using data from pop-off archival transmitting (PATs) tags applied to turtles captured on the Grand Banks off Nova Scotia, Canada	I
Create database to include the AMAPPS data	Build on the existing NEFSC Oracle databases to store and process the data collected under the various AMAPPS projects	J

Table 3. Papers (completed, in review, or in progress) that document some aspect of the AMAPPS work, and the appendix that provides more information about the paper. Authors associated with AMAPPS are in bold.

Papers associated with AMAPPS work	Appendix
Completed in 2011	
Goodman Hall A, Belskis LC. 2012. Guide to the aerial identification of sea turtles in the US Atlantic and Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-633, 24 pp. or online at http://www.nefsc.noaa.gov/read/protspp/mainpage/AMAPPS/docs/TM_633_Goodman-Hall_Belskis_Aerial_ID.pdf	N/A
Completed in 2012	
Palka D. 2012. Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2011 line transect survey. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 12-29; 37 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://nefsc.noaa.gov/publications/crd/crd1103/	E
Completed in 2013	
Waring GT, Josephson E, Maze-Foley K, Rosel, PE, editors. 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2012. NOAA Tech Memo NMFS NE 223; 419 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/publications/tm/tm223/	E
In review	
Waring GT, **Josephson E**, Maze-Foley K, Rosel, PE, editors. In review. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2013. Will be submitted as a NOAA Tech Memo NMFS NE.	E
Cholewiak D, Baumann-Pickering S, **Van Parijs SM**. Description of sounds associated with Sowerby's beaked whales (*Mesoplodon bidens*) in the western North Atlantic. In revision for the *Journal of the Acoustical Society of America*.	F
Cholewiak D, Risch D, Valtierra R, **Van Parijs SM**. Methods for passive acoustic tracking of marine mammals: estimating calling rates, depths and detection probability for density estimation. Invited book chapter.	F
Avens L, Goshe LR, Pajuelo M, Bjorndal KA, MacDonald BD, Lemons GE, Bolten AB, Seminoff JA. Complementary skeletochronology and stable isotope analyses offer new insight into juvenile loggerhead sea turtle oceanic stage duration and growth dynamics. Submitted to *Marine Ecology Progress Series*.	H

Table 3. cont. Papers (completed, in review, or in progress) that document some aspect of the AMAPPS work, and the appendix that provides more information about the paper. Authors associated with AMAPPS are in bold.

Papers associated with AMAPPS work	Appendix
In progress	
Gilbert JR, **Waring GT**, DiGiovanni, R, **Josephson E**. 2012. Gulf of Maine harbor seal abundance estimate 2012. Will be submitted as a NOAA Tech Memo NMFS NE.	D
Gilbert JR, **Waring GT**. Aerial survey design proposal for 2011 New England harbor seal abundance survey. Will be submitted as a NOAA Tech Memo NMFS NE.	D
Garrison LP, **Barry K**, Mullin KD. Abundance of cetaceans along the southeastern U.S. coast from aerial and vessel based visual line transect surveys. Will be submitted as a NOAA Tech Memo NMFS SE.	E
Waring GT, Josephson E, Maze-Foley K, Rosel, PE, editors. In review. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2013. Will be submitted as a NOAA Tech Memo NMFS NE.	E

Table 4. Approximate number of groups and individual (indiv) animals detected during the spring (March – May) and fall (September – November) 2012 AMAPPS surveys conducted in waters from the southeastern tip of Florida to the southern tip of Nova Scotia.

		Spring		Fall	
Species		Groups	Indiv	Groups	Indiv
Atlantic spotted dolphin	*Stenella frontalis*	21	184	24	242
Beaked whales	*Mesoplodons spp*	3	6	0	0
Bottlenose dolphin spp.	*Tursiops truncatus*	140	955	162	2076
Atlantic spotted or Bottlenose dolphin		18	26	18	85
Common dolphin	*Delphinus delphis*	47	79	37	752
Common or White-sided dolphin		3	16	3	29
Cuvier's beaked whale	*Ziphius cavirostris*	3	7	0	0
Fin whale	*Balaenoptera physalus*	24	38	19	24
Fin or sei whale	*B. physalus or B. borealis*	4	22	3	3
Harbor porpoise	*Phocoena phocoena*	76	97	19	52
Humpback whale	*Megaptera novaeangliae*	15	19	11	18
Minke whale	*B. acutorostrata*	10	11	7	15
Right whale	*Eubalaena glacialis*	4	8	0	0
Risso's dolphin	*Grampus griseus*	27	114	11	77
Pilot whale spp.	*Globicephala spp.*	4	107	20	276
Sei whale	*Balaenoptera borealis*	5	6	3	9
Sperm whale	*Physeter macrocephalus*	6	6	2	2
Striped dolphin	*Stenella coeruleoalba*	1	100	4	188
Unid dolphin	*Delphinidae*	45	502	29	240
Unid whale	*Mysticeti*	12	15	9	10
White beaked dolphin	*Lagenorhynchus albirostris*	1	6	0	0
White-sided dolphin	*Lagenorhynchus acutus*	20	208	8	278
Total cetaceans		**489**	**2532**	**389**	**4376**
Leatherback turtle	*Dermochelys coriacea*	77	88	116	123
Loggerhead turtle	*Caretta caretta*	660	751	917	1064
Green turtle	*Chelonia mydas*	43	45	19	20
Kemp's ridley	*Lepidochelys kempii*	5	5	18	19
Unid hardshell turtle	*Chelonioidea*	629	689	774	884
Total turtles		**1414**	**1578**	**1844**	**2110**
Harbor seal	*Phoca vitulina*	0	0	1	1
Gray seal	*Halichoerus grypus*	1	1	2	2
Unid seal	*Pinniped*	48	52	3	3
Total all species		**1952**	**4163**	**2239**	**6492**

Figure 1. Tracklines completed during the spring (March – May) 2012 AMAPPS aerial surveys.

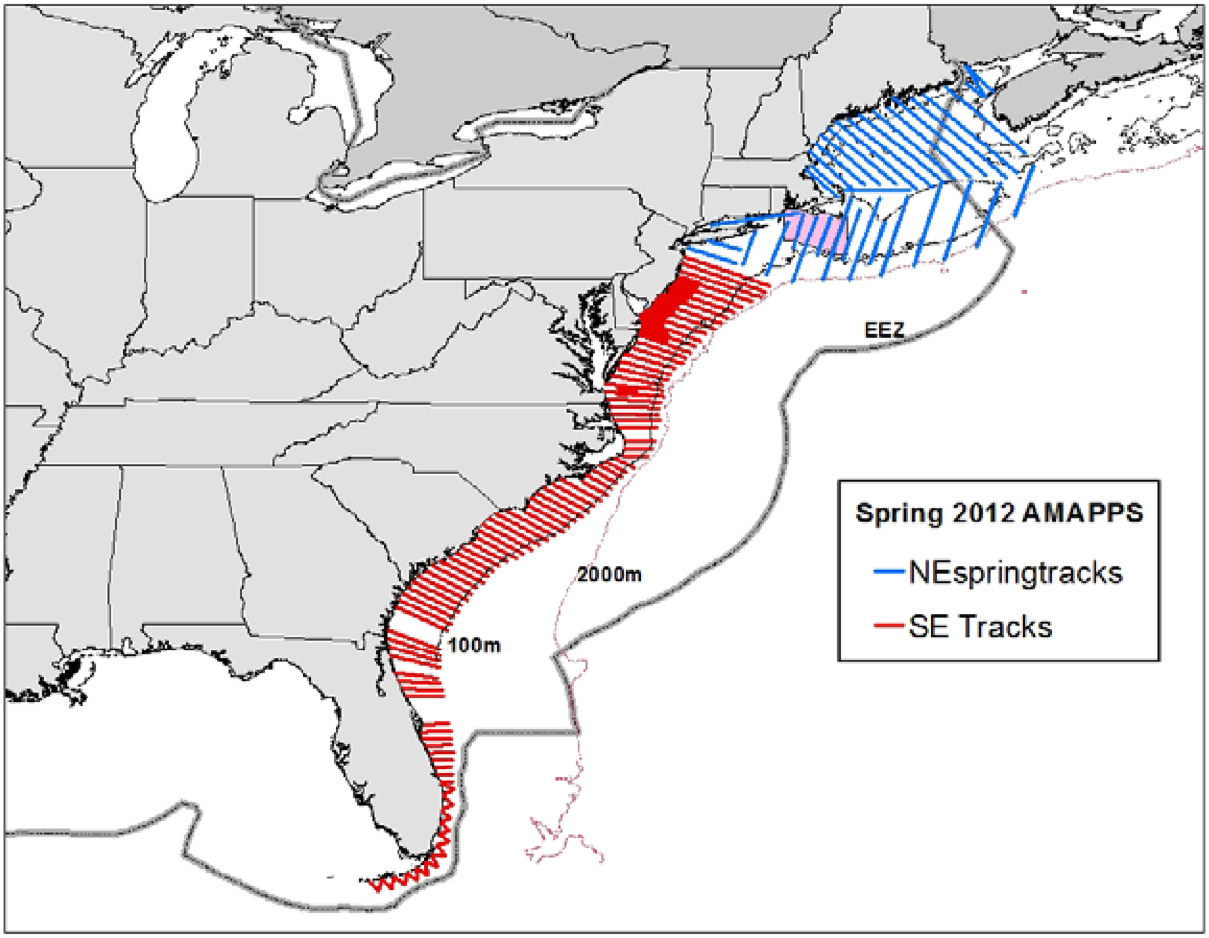
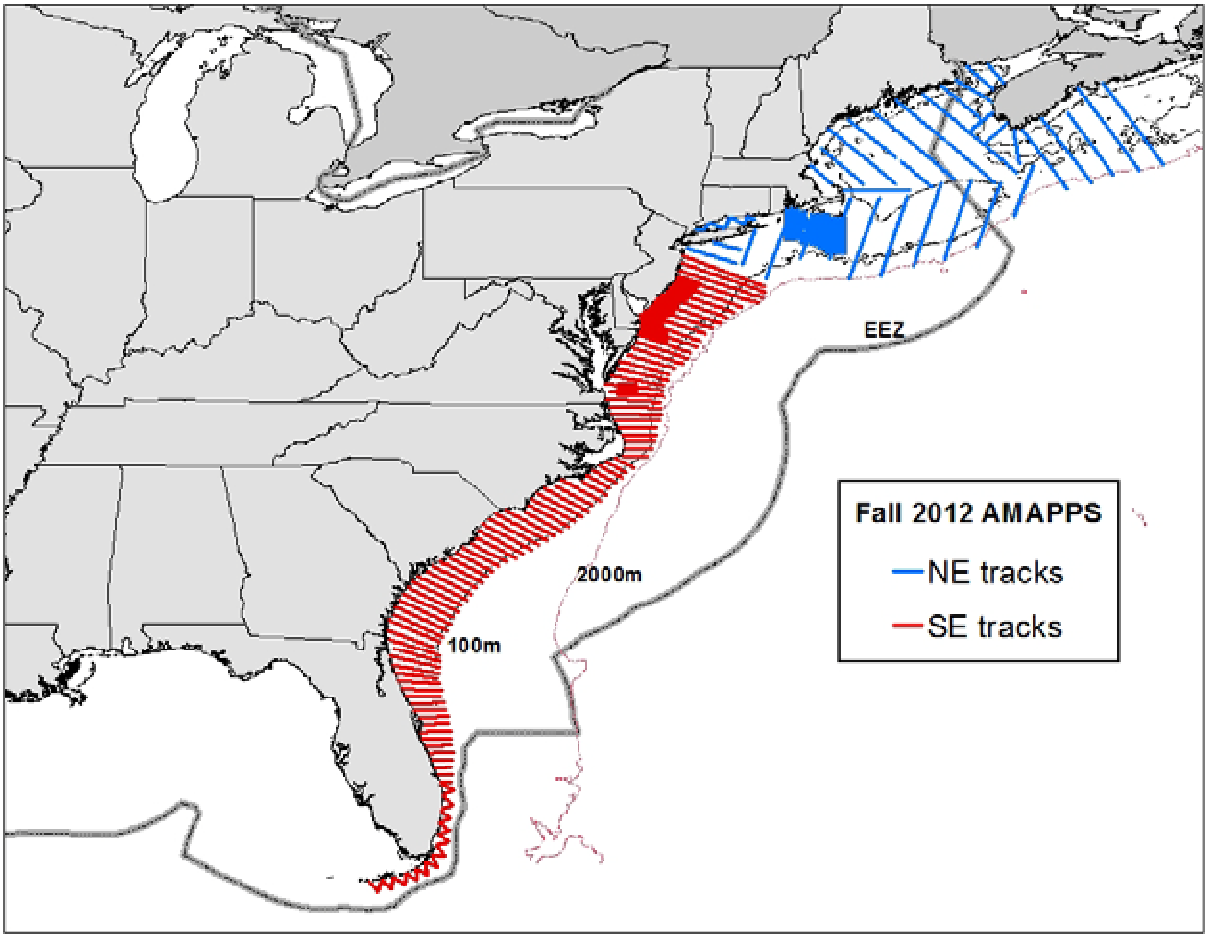


Figure 2. Tracklines completed during the fall (September – November) 2012 AMAPPS aerial surveys.



Appendix A: *Northern leg of aerial abundance surveys during spring and fall 2012: Northeast Fisheries Science Center*

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SUMMARY

During 28 March – 3 May 2012 and 17 October – 16 November 2012, the Northeast Fisheries Science Center (NEFSC) conducted aerial abundance surveys targeting marine mammals and sea turtles. The southwestern extent of both surveys was New Jersey. The northeastern extent was the southern tip of Nova Scotia, Canada for the spring survey and it was off Halifax, Nova Scotia, Canada for the fall survey. Both surveys covered waters from the coast line to about the 2000 m depth contour. Track lines were flown 183 m (600 ft) above the water surface, at about 200 kph (110 knots). The two-independent team methodology was used to collect the data. In Beaufort sea states of 4 and less, about 6800 km of on-effort track lines were surveyed in the spring survey and about 7100 km in the fall survey. During spring, over 700 individuals within over 200 groups of 23 species (or species groups) of cetaceans, seals and large fish were detected. The most regularly detected small cetacean species were white-sided dolphins, bottlenose dolphins and harbor porpoises; fin whales were the most common large whale; no sea turtles were detected. During fall, over 1700 individuals within over 240 groups of 26 species (or species groups) of cetaceans, sea turtles, seals, and large fish species were detected. The most regularly detected small cetacean species were common dolphins, white-sided dolphins and bottlenose dolphins; the most common large whales were humpback whales, fin whales and minke whales; and the most common turtle was the loggerhead turtle.

OBJECTIVES

The objectives of these aerial surveys were to collect the data needed to estimate abundance of cetaceans and turtles in the study area, and to investigate how the animal's distribution and abundance relate to their physical and biological ecosystem.

CRUISE PERIOD AND AREA

Spring survey

The spring survey was conducted during 28 March – 3 May 2012. The study area extended from New Jersey to the southern tip of Nova Scotia, Canada, from the coast line to about the 2000 m depth contour (Figure A1).

Fall survey

The fall survey was conducted during 17 October – 16 November 2012. The study area extended from New Jersey to Scotia shelf waters off Halifax, Canada, from the coast line to about the 2000 m depth contour (Figure A2). This included broad scale coverage over this entire area and fine scale coverage over the BOEM wind energy area south of Massachusetts and Rhode Island.

METHODS

The aerial surveys were conducted on a DeHavilland Twin Otter DHC-6 aircraft over Atlantic Ocean waters off the east coast of the U.S. and Canada. Track lines were flown 183 m (600 ft) above the water surface, at about 200 kph (110 knots), when Beaufort sea state conditions were below five, and when there was at least two miles of visibility.

When a cetacean, seal, turtle, sunfish, or basking shark was observed the following data were collected:

- Time animal passed perpendicular to the observer;
- Species identification;
- Species identification confidence level (certain, probable, not sure);
- Best estimate of the group size;
- Angle of declination between the track line and location of the animal group when it passed abeam (measured to the nearest one degree by inclinometers or marks on the windows, where 0º is straight down);
- Cue (animal, splash, blow, footprint, birds, vessel/gear, windrows, disturbance, or other);
- Swim direction (0º indicates animal was swimming parallel to the track line in the same direction the plane was flying, 90º indicates animal was swimming perpendicular to the track line and towards the right, etc.);
- If the animal appeared to react to the plane (yes or no);
- If the animal was diving (yes or no), and;
- Comments, if any.

Other fish species were also recorded opportunistically. Species identifications were recorded to the lowest taxonomic level possible.

At the beginning of each leg, and when conditions changed the following effort data were collected:

- Initials of person in the pilot seats and at the observation stations;
- Beaufort sea state (recorded to one decimal place);
- Water turbidity (clear, moderately clear, or turbid);
- Percent cloud cover (0 – 100%);
- Angle glare swath started and ended at (0 – 359º), where 0º was the track line in the direction of flight and 90º was directly abeam to the right side of the track line, etc.;
- Magnitude of glare (none, slight, moderate, or excessive); and
- Subjective overall quality of viewing conditions (excellent, good, moderate, fair, or poor), where data collected in poor conditions indicated conditions were so poor that that part of the track line should not be used in analyses.

In addition, the location of the plane was recorded every two seconds with a GPS that was attached to the data entry program. Sightings and effort data were collected by a computer program called VOR.exe, version 8.75 originally created by Phil Lovell and Lex Hiby.

To help correct for perception bias, data were collected to estimate the parameter *g(0)*, the probability of detecting a group on the track line. This was accomplished by using the two independent team data collection method (Laake and Borchers 2004).

Onboard, in addition to two pilots, were six scientists who were divided into two teams. One team, the primary forward team, consisted of a recorder and two observers viewing through the two forward right and left bubble windows. The other team, the independent back team, consisted of one observer viewing through the back belly window, one observer viewing through either the right or left back window (depending on which side the sighting conditions were best), and a recorder. The two observer teams operated on independent intercom channels so that they were not able to cue one another to sightings.

When at the end of track lines or about every 30 – 40 mins, scientists rotated between the observations positions. The belly window observer was limited to approximately a 30º view on both sides of the track line. The bubble window and back side observers searched from straight down to the horizon, with a concentration on waters between straight down (0º) and about 60º up from straight down.

When both teams could not identify the species of a group that was within about 60º of the track line and there was a high chance that the group could be relocated, sighting effort was broke off, and the plane returned to the group to confirm the species identification and group size. The marine mammal and turtle data will be reviewed at a later time to identify duplicate sightings made by the two teams based upon time, location, and position relative to the trackline.

RESULTS

The observers and pilots who collected these data are listed in Table A1.

Spring survey

Nine of the 37 available days had sufficiently good weather to conduct the survey. There were about 6806 km of "on-effort" track lines.

On the on-effort track lines, 426 and 734 individual cetaceans within 157 and 198 groups were detected by the back and front teams, respectively (Table A2). The locations of sightings seen on the on-effort spring transect legs, by species, are displayed in Figures A3 – A9, where harbor porpoises are in Figure A3, dolphins in Figures A4 – A5, whales in Figures A6 – A8, seals in A8, and other species in Figure A9. The sightings included 18 species (or species groups) of cetaceans: humpback whales, minke whales, fin whales, sei whales, right whales, sperm whales, Cuvier's beaked (goose-beaked) whales, beaked whales spp., pilot whales, unidentified whale, white-sided dolphins, white-beaked dolphins, common dolphins, Risso's dolphins, bottlenose dolphins, striped dolphins, unidentified dolphin, and harbor porpoises. In addition, basking sharks, sunfish and seals (either harbor or gray seals) were also seen. No sea turtles were detected. The most regularly detected small cetacean species were white-sided dolphins, bottlenose dolphins and harbor porpoises, along with one large group of about 100 striped dolphins. Fin whales and whales that were either a fin or sei whale were the most common large whale.

Fall survey

Of the 31 days allocated to this project, 11 days had sufficiently good weather to conduct the survey. There were about 7,134 km of "on-effort" track lines (Figure A2).

On the on-effort track lines, 1173 and 1619 individual cetaceans (from 135 and 154 groups) were detected by the back and front teams, respectively (Table A3). The locations of sightings seen on the on-effort spring transect legs, by species, are displayed in Figures A10 – A17, where harbor porpoises are in Figure A10, dolphins in Figures A11 – A12, whales in Figures A13 – A14, turtles in A15, seals in A16, and other species in Figure A17. These comprised of 16 species (or species groups) of cetaceans: minke whales, fin whales, sei whales, right whales, sperm whales, humpback whales, unidentified whales, pilot whales spp., Risso's dolphins, white-sided dolphins, white-beaked dolphins, common dolphins, bottlenose dolphins, striped dolphins, unidentified dolphins, and harbor porpoises. In addition, leatherback turtles, loggerhead turtles, green turtles, unidentified hardshell turtles, basking sharks, great white sharks, ocean sunfishes, and seals (either harbor or gray seals) were seen. The most regularly detected small cetacean species were common dolphins, white-sided dolphins and bottlenose dolphins; the most common large whales were humpback whales, fin whales and minke whales; and the most common turtle was the loggerhead turtle.

DISPOSITION OF DATA

All data collected during this survey will be maintained by the Protected Species Branch at NEFSC in Woods Hole, MA and are available from the NEFSC's Oracle database.

PERMITS

NEFSC was authorized to conduct these research activities during this survey under US Permit No. 775-1875 issued to the NEFSC by the NMFS Office of Protected Resources. The NOAA aircraft was granted diplomatic overflight clearance in Canadian airspace with the overflight clearance number 0536-US-2012-10-TC. NEFSC was authorized to conduct these research activities in Canadian airspace under the Species at Risk Permit license number 330996.

ACKNOWLEDGEMENTS

The funds for this project came from the Bureau of Ocean Energy Management (BOEM) and the US Navy through the respective Interagency Agreements for the AMAPPS project. Staff time was also provided by the NOAA Fisheries Service, Northeast Fisheries Science Center (NEFSC) and NOAA Aircraft Operations Center (AOC). We would like to thank the pilots and observers involved in collecting the spring and fall 2012 aerial surveys and in particular David Cowan from NOAA Aircraft Operations Center (AOC) who was very helpful preparing for these flights.

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Laake JL, Borchers DL. 2004. Methods for incomplete detection at distance zero, In: Advanced distance sampling, edited by S. T. Buckland, D. R. Andersen, K. P. Burnham, J. L. Laake, and L. Thomas, pp. 108–189, Oxford University Press, New York.

Table A1. List of observers and pilots that participated in the spring and fall 2012 Northeast AMAPPS aerial surveys, along with their affiliations.

Name	Affiliation	Spring	Fall
OBSERVERS			
Tim Cole	Northeast Fisheries Science Center, Woods Hole, MA	P	P
Peter Duley	Northeast Fisheries Science Center, Woods Hole, MA	P	P
Allison Henry	Northeast Fisheries Science Center, Woods Hole, MA	P	P
Christin Khan	Northeast Fisheries Science Center, Woods Hole, MA	P	
Debra Palka	Northeast Fisheries Science Center, Woods Hole, MA	P	P
Corey Accardo	Integrated Statistics, Inc, Woods Hole, MA		P
Mary Jo Barkaszi	Integrated Statistics, Inc, Woods Hole, MA	P	
Lisa Barry	Integrated Statistics, Inc, Woods Hole, MA	P	
Allison Challiett	Integrated Statistics, Inc, Woods Hole, MA	P	P
Robert DiGiovanni	Integrated Statistics, Inc, Woods Hole, MA	P	P
Marjorie Foster	Integrated Statistics, Inc, Woods Hole, MA		P
Gary Friedrichsen	Integrated Statistics, Inc, Woods Hole, MA		P
Jennifer Gatzke	Integrated Statistics, Inc, Woods Hole, MA	P	P
Joy Hampp	Integrated Statistics, Inc, Woods Hole, MA		P
Rachel Hardee	Integrated Statistics, Inc, Woods Hole, MA		P
Richard Holt	Integrated Statistics, Inc, Woods Hole, MA	P	P
Sarah Mussoline	Integrated Statistics, Inc, Woods Hole, MA		P
PILOTS			
Nicholas Toth	NOAA Aircraft Operations Center, Tampa, FL	P	
Mark Nelson	NOAA Aircraft Operations Center, Tampa, FL	P	
Phillip Eastman	NOAA Aircraft Operations Center, Tampa, FL	P	
Michael Hirsch	NOAA Aircraft Operations Center, Tampa, FL	P	P
Michael Silagi	NOAA Aircraft Operations Center, Tampa, FL		P
Kevin Doremus	NOAA Aircraft Operations Center, Tampa, FL		P
David Cowen	NOAA Aircraft Operations Center, Tampa, FL		P

Table A2. Spring 2012 Northeast AMAPPS aerial survey: Number of groups and individuals of species detected while on-effort by the front and back survey teams. Some of the groups seen by the back team were also seen by the front team.

		Number of groups		Number of individuals	
Species		Back	Front	Back	Front
Beaked whales spp.	*Mesoplodon spp.*	0	3	0	6
Bottlenose dolphin spp.	*Tursiops truncatus*	14	10	64	107
Common dolphin	*Delphinus delphis*	4	4	36	36
Common or white-sided dolphin		3	3	10	16
Fin whale	*Balaenoptera physalus*	13	17	15	26
Fin or sei whale	*B. physalus or B. borealis*	5	4	6	22
Goosebeaked whale	*Ziphius cavirostris*	1	0	4	0
Harbor porpoise	*Phocoena phocoena*	56	76	70	97
Humpback whale	*Megaptera novaeangliae*	10	9	16	12
Minke whale	*B. acutorostrata*	3	5	3	5
Right whale	*Eubalaena glacialis*	2	2	2	2
Risso's dolphin	*Grampus griseus*	4	8	8	29
Pilot whale spp.	*Globicephala spp.*	2	2	3	2
Sei whale	*Balaenoptera borealis*	0	5	0	6
Sperm whale	*Physeter macrocephalus*	1	2	1	2
Striped dolphin	*Stenella coeruleoalba*	0	1	0	100
Unid dolphin	*Delphinidae*	15	15	33	38
Unid whale	*Mysticeti*	5	11	5	14
White beaked dolphin	*Lagenorhynchus albirostris*	1	1	7	6
White-sided dolphin	*Lagenorhynchus acutus*	18	20	143	208
Total cetaceans		**157**	**198**	**426**	**734**
Basking shark	*Cetorhinus maximus*	5	8	6	8
Ocean sunfish	*Mola mola*	1	4	1	4
Hammerhead shark	*Sphyrna spp.*	1	0	1	0
Gray seal	*Halichoerus grypus*	1	0	1	0
Unid seal	*Pinniped*	48	48	3	52
Total all species		**213**	**258**	**438**	**798**

Table A3. Fall 2012 Northeast AMAPPS aerial survey: Number of groups and individuals of species detected while on-effort by the front and back survey teams. Some of the groups seen by the back team were also seen by the front team.

		Number of groups		Number of individuals	
Species		Back	Front	Back	Front
Bottlenose dolphin spp.	*Tursiops truncatus*	20	14	265	187
Common dolphin	*Delphinus delphis*	34	34	607	663
Common or white-sided dolphin		2	3	19	29
Fin whale	*Balaenoptera physalus*	10	13	10	14
Fin or sei whale	*B. physalus or B. borealis*	1	3	1	3
Harbor porpoise	*Phocoena phocoena*	26	19	35	52
Humpback whale	*Megaptera novaeangliae*	5	11	7	18
Minke whale	*B. acutorostrata*	3	7	3	15
Right whale	*Eubalaena glacialis*	1	0	1	0
Risso's dolphin	*Grampus griseus*	7	9	15	30
Pilot whale spp.	*Globicephala spp.*	2	4	8	8
Sei whale	*Balaenoptera borealis*	0	3	0	9
Sperm whale	*Physeter macrocephalus*	1	2	1	2
Striped dolphin	*Stenella coeruleoalba*	3	4	23	188
Unid dolphin	*Delphinidae*	8	13	30	116
Unid whale	*Mysticeti*	5	7	5	7
White beaked dolphin	*Lagenorhynchus albirostris*	1	0	4	0
White-sided dolphin	*Lagenorhynchus acutus*	6	8	139	278
Total cetaceans		**135**	**154**	**1173**	**1619**
Basking shark	*Cetorhinus maximus*	29	34	35	44
Ocean sunfish	*Mola mola*	18	19	18	19
Great white shark	*Carcharodon carcharias*	1	0	1	0
Leatherback turtle	*Dermochelys coriacea*	10	5	10	5
Loggerhead turtle	*Caretta caretta*	22	16	22	16
Green turtle	*Chelonia mydas*	0	1	0	1
Unid hardshell turtle	*Chelonioidea*	0	1	0	1
Harbor seal	*Phoca vitulina*	1	1	1	1
Gray seal	*Halichoerus grypus*	0	2	0	2
Unid seal	*Pinniped*	4	3	4	3
Total all species		**220**	**236**	**1264**	**1711**

Figure A1. Spring 2012 Northeast AMAPPS aerial survey (28 March – 3 May 2012): completed tracklines.

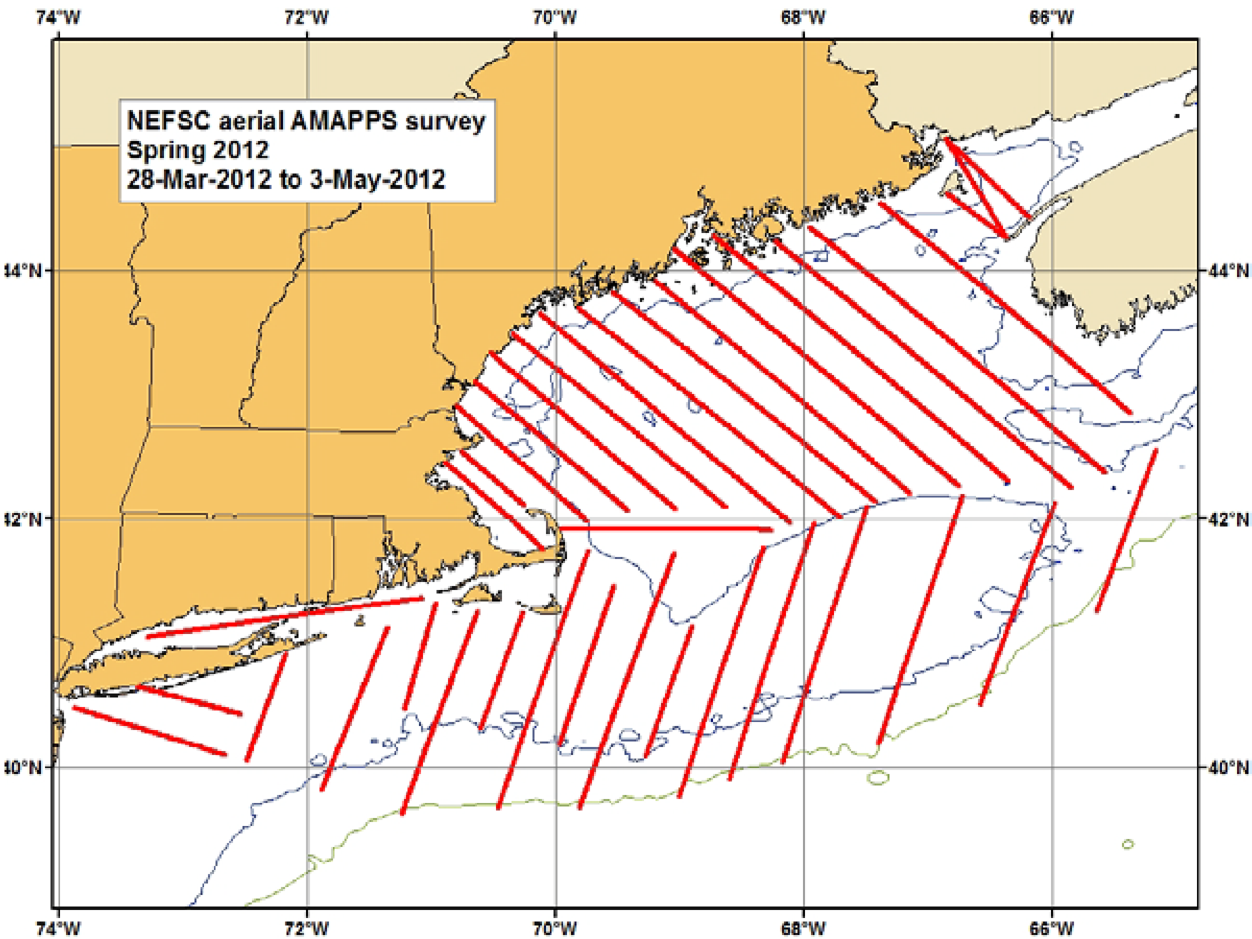


Figure A2. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): completed tracklines.

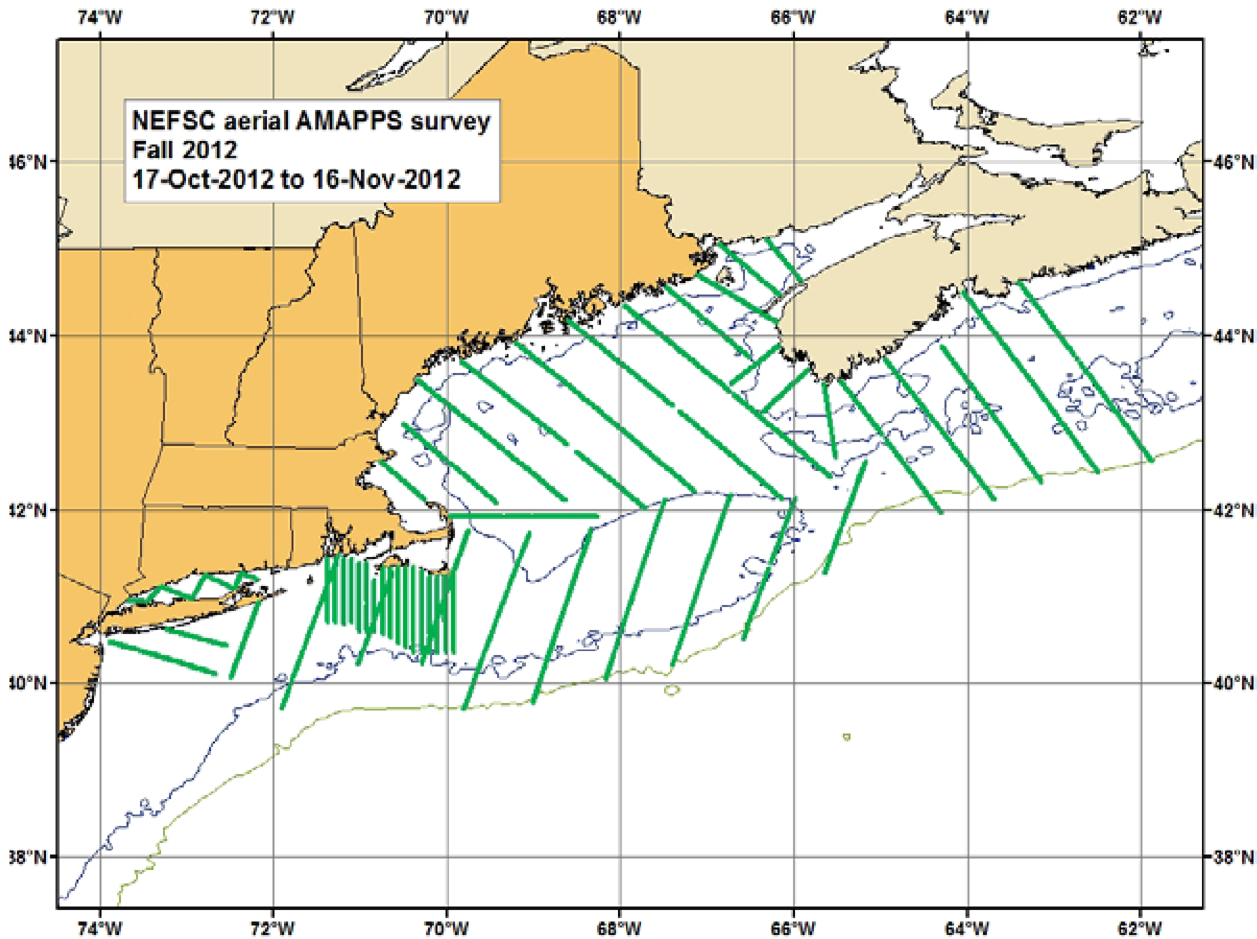


Figure A3. Spring 2012 Northeast AMAPPS aerial survey (28 March – 03 May 2012): Locations of harbor porpoises detected by the front team. Size of circle corresponds to group size. 100 m and 2000 m depth contours shown.

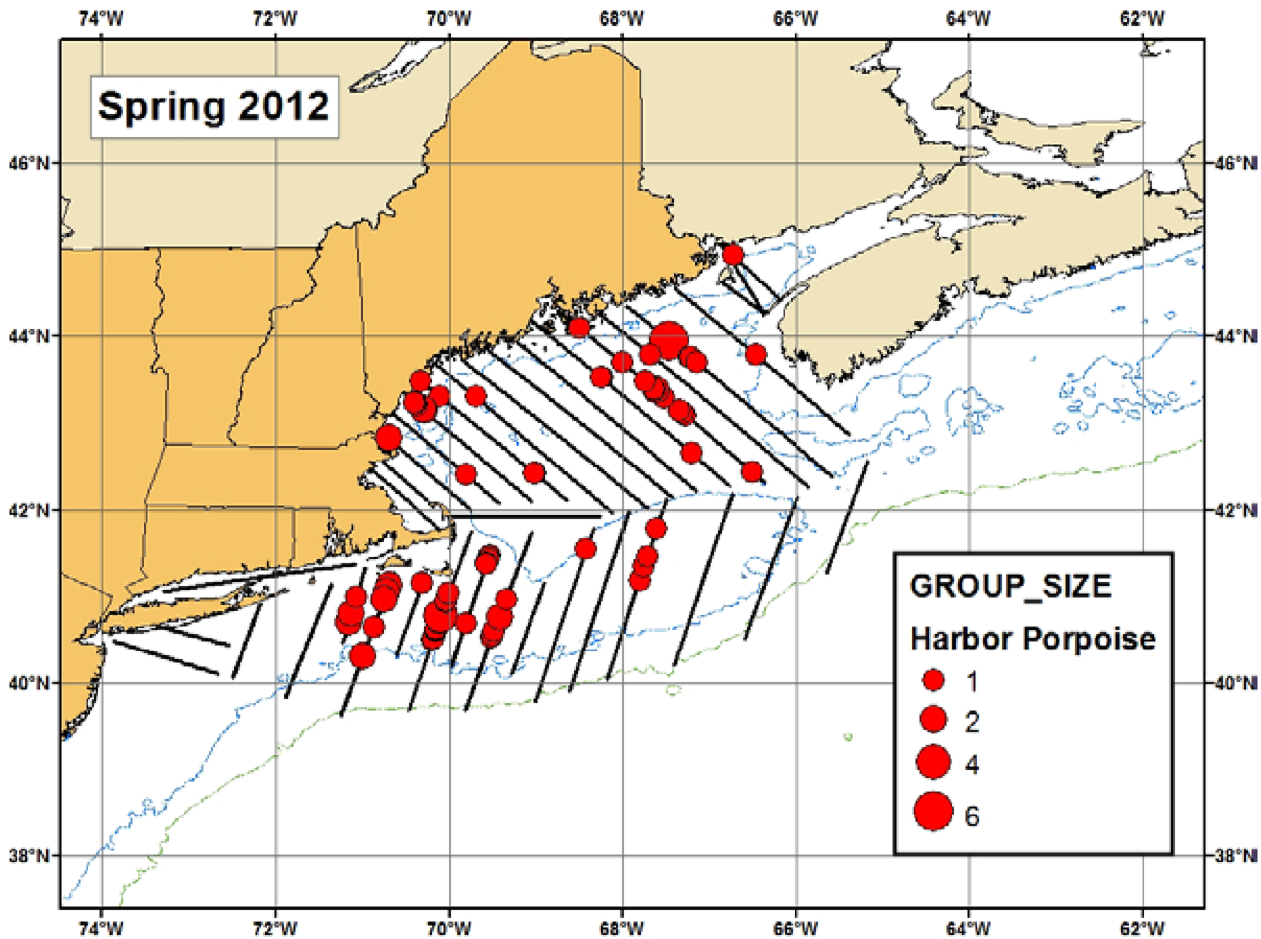


Figure A4. Spring 2012 Northeast AMAPPS aerial survey (28 March – 03 May 2012): Locations of common dolphins (red), white-sided dolphins (beige), common or white-sided dolphins (blue), and bottlenose dolphins (green) detected by the front team. Size of circle corresponds to group size. 100 m and 2000 m depth contours shown.

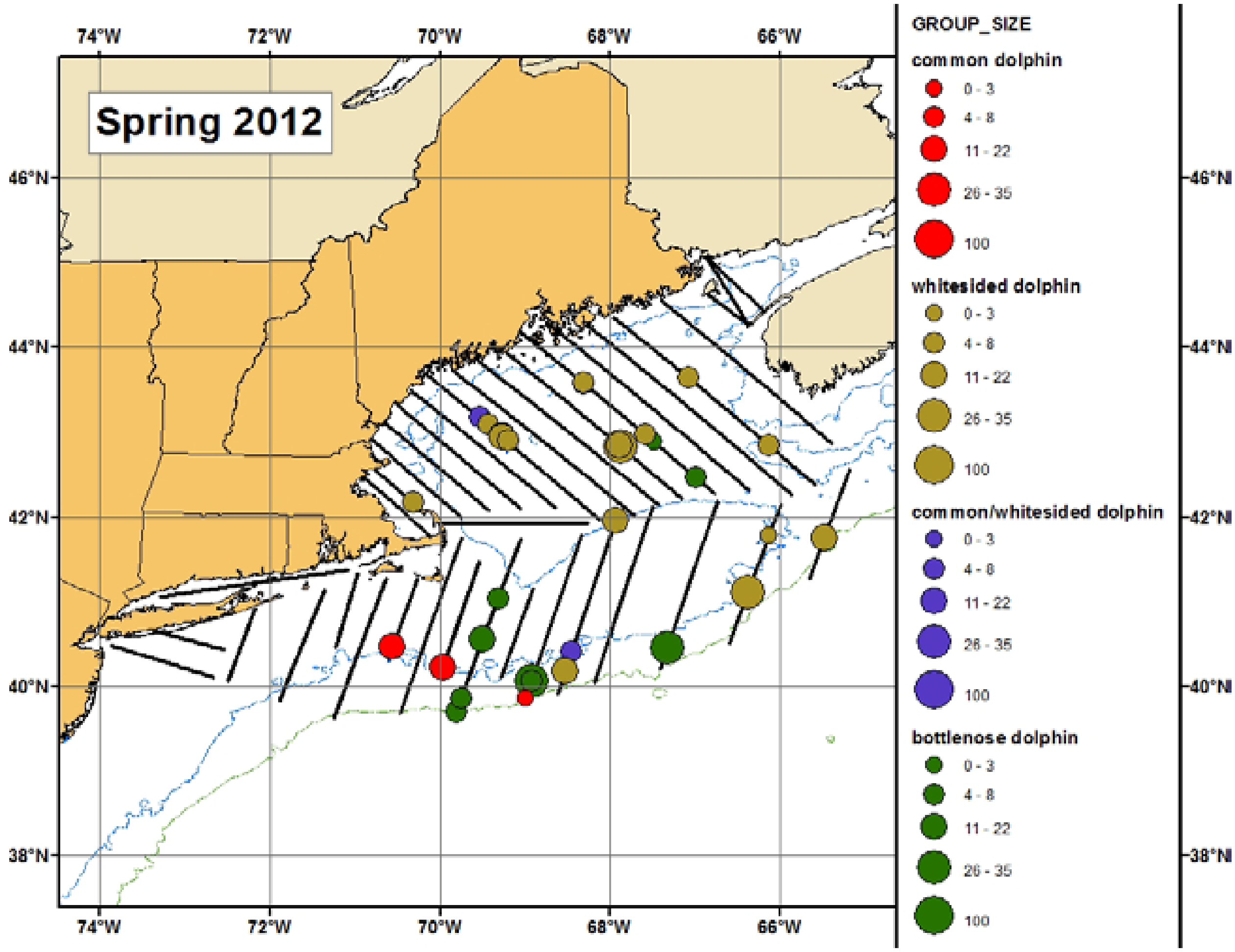


Figure A5. Spring 2012 Northeast AMAPPS aerial survey (28 March – 03 May 2012): Locations of white beaked dolphins (red), Risso's dolphins (blue), striped dolphins (yellow) and unidentified dolphins (green) detected by the front team. Size of circle corresponds to group size. 100 m and 2000 m depth contours shown.

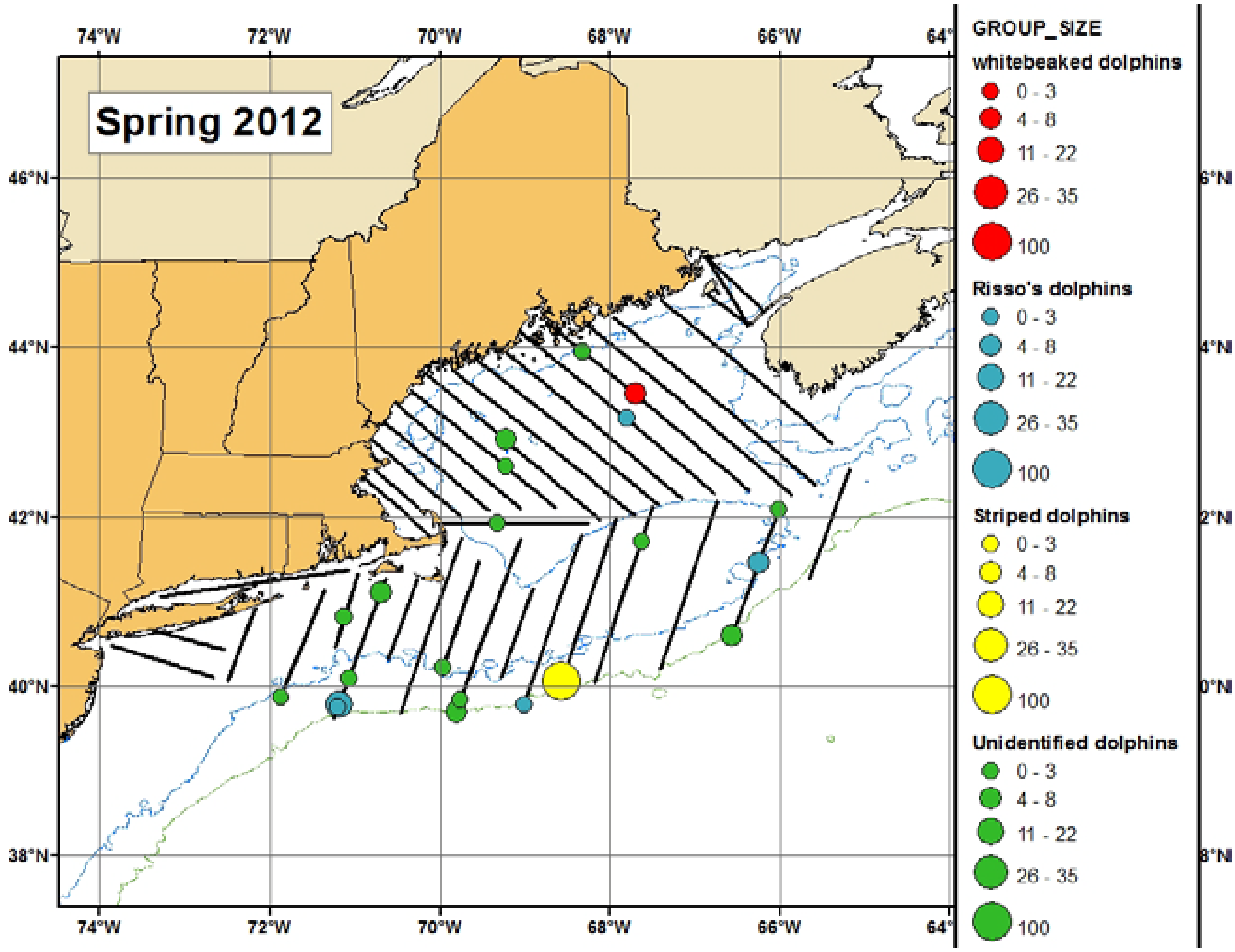


Figure A6. Spring 2012 Northeast AMAPPS aerial survey (28 March – 03 May 2012): Locations of fin whales (green), sei whales (beige) and groups that were either fin or sei whales (blue) as detected by the front team. Size of circle corresponds to group size. 100 m and 2000 m depth contours shown.

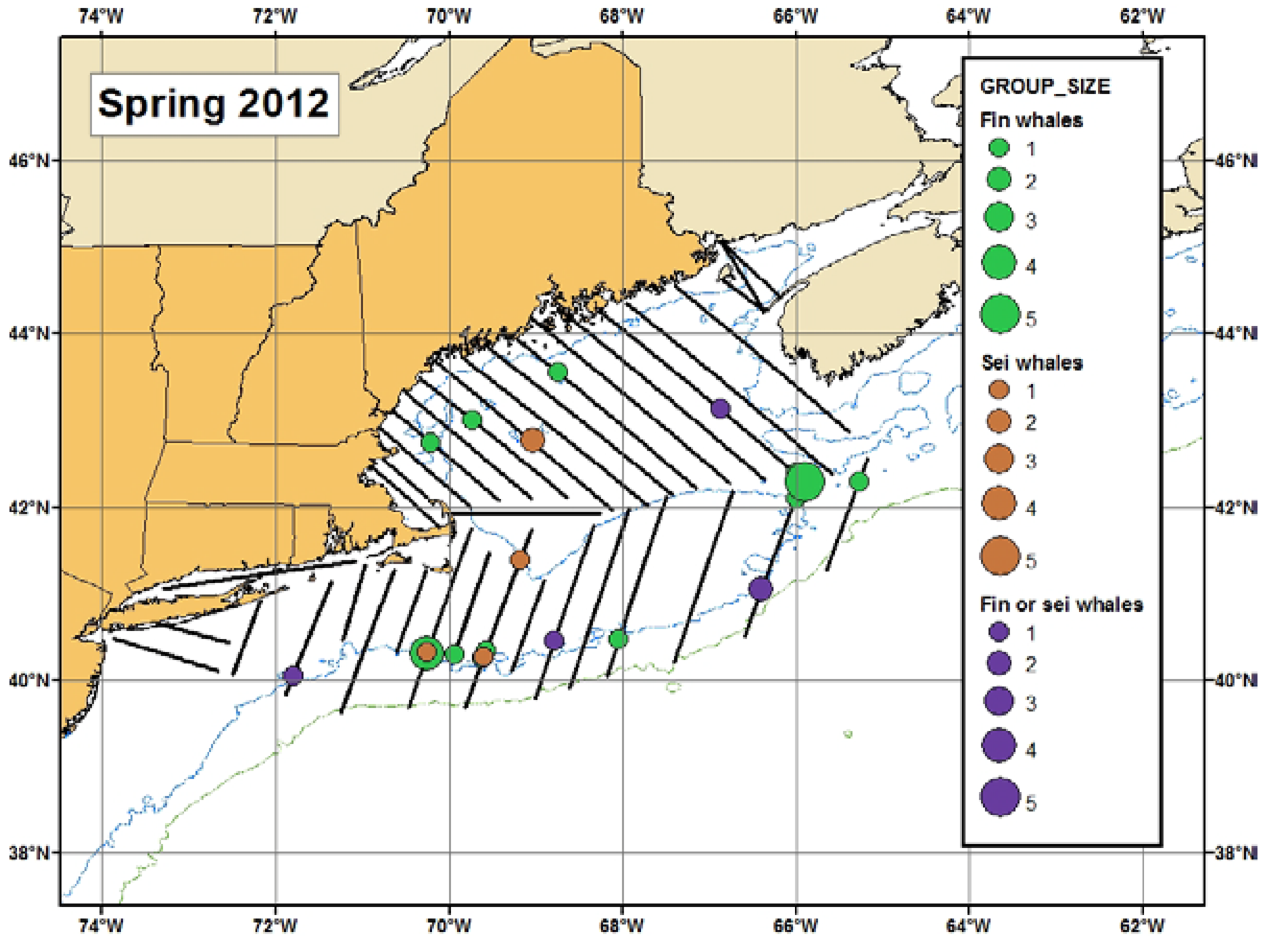


Figure A7. Spring 2012 Northeast AMAPPS aerial survey (28 March – 03 May 2012): Locations of unidentified beaked whales (purple), Cuvier's beaked whales (green), humpback whales (blue), minke whales (beige), right whales (red) and sperm whales (yellow) detected by the front team. 100 m and 2000 m depth contours shown.

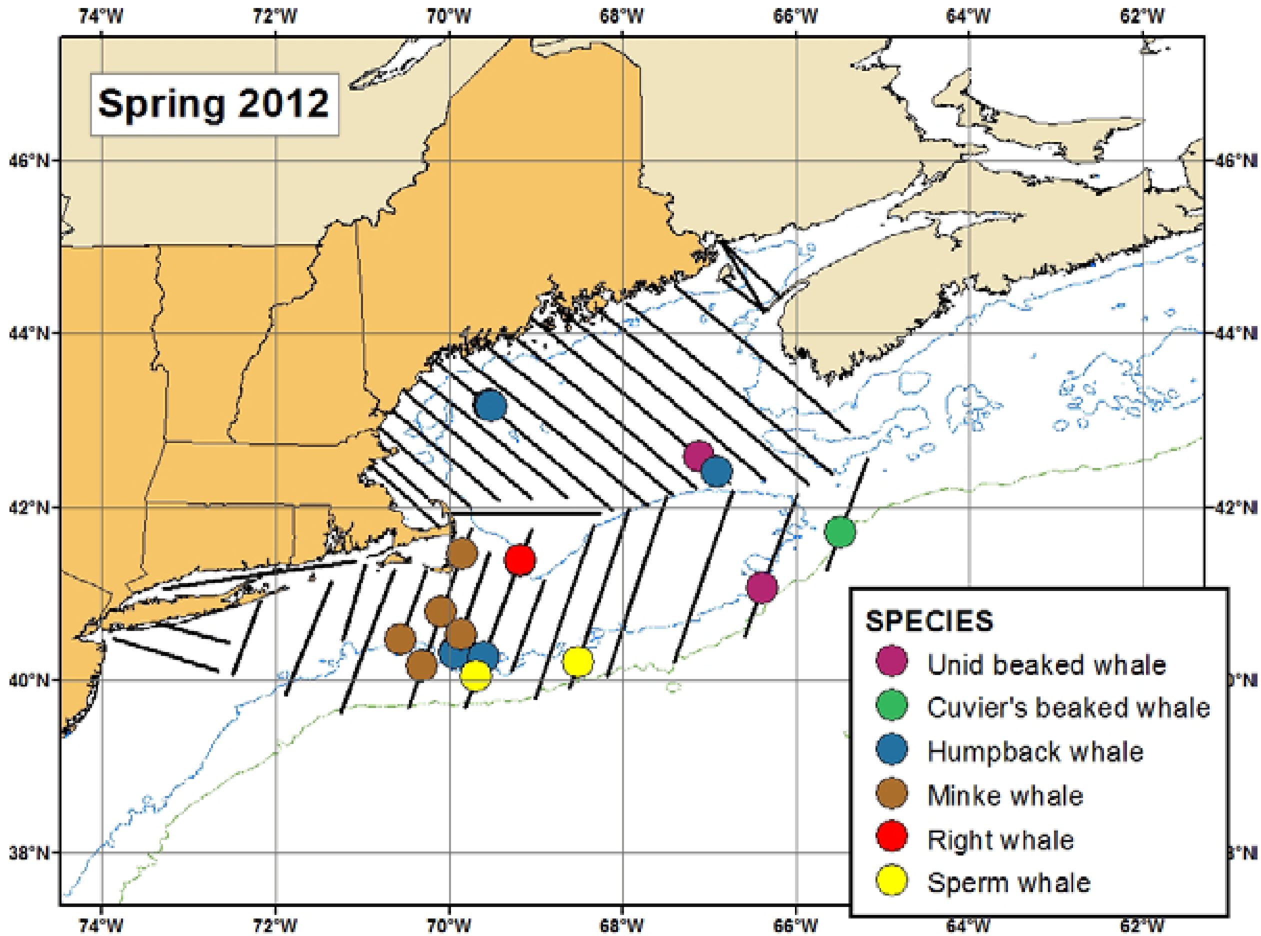


Figure A8. Spring 2012 Northeast AMAPPS aerial survey (28 March – 03 May 2012): Locations of pilot whales (green) and unidentified seals (purple) detected by the front team. 100 m and 2000 m depth contours shown.

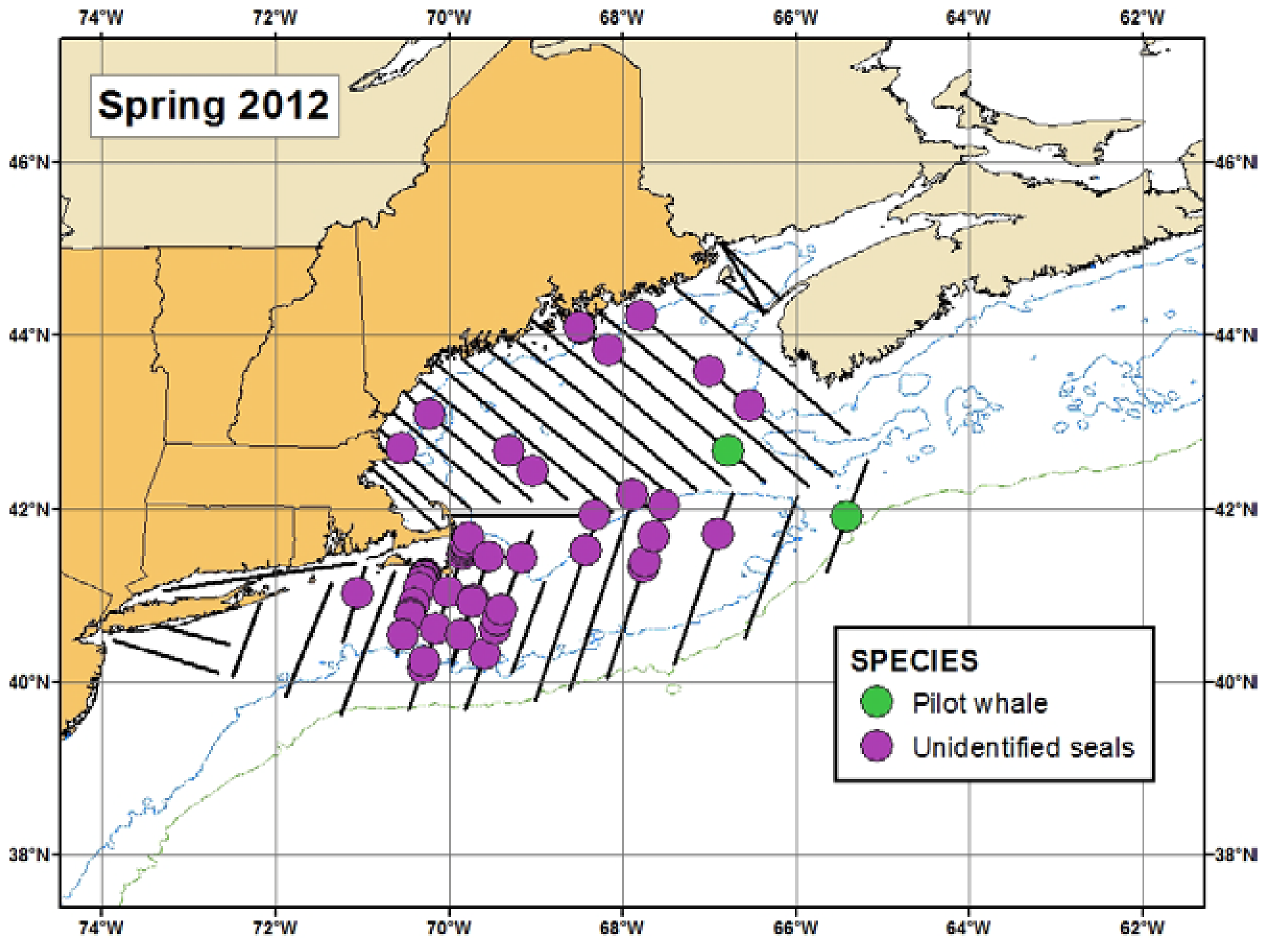


Figure A9. Spring 2012 Northeast AMAPPS aerial survey (28 March – 03 May 2012): Locations of basking sharks (beige) and ocean sun fish (purple) detected by the front team. 100 m and 2000 m depth contours shown.

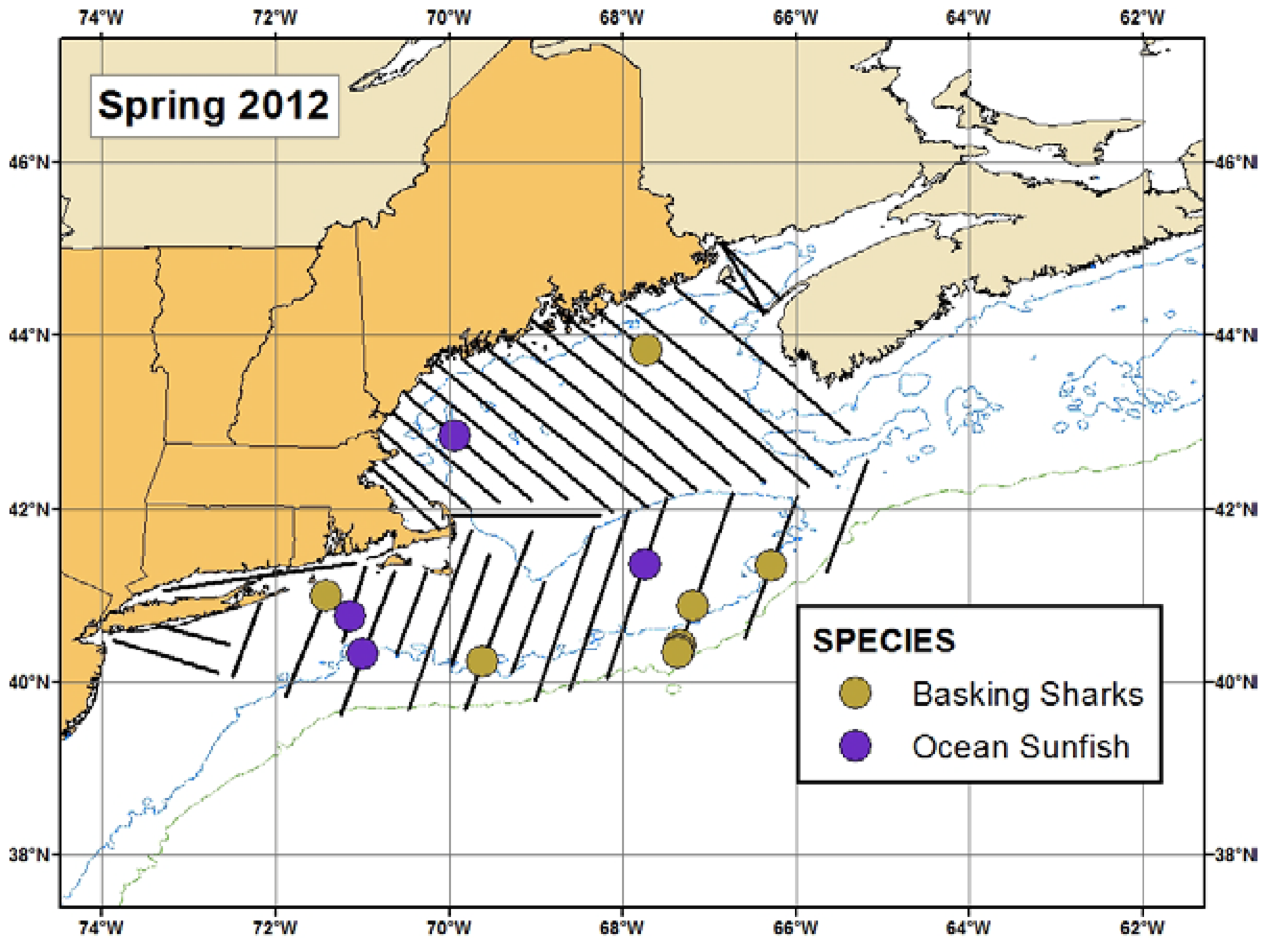


Figure A10. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): Locations of harbor porpoises (red) detected by the front team. 100 m and 2000 m depth contours shown.

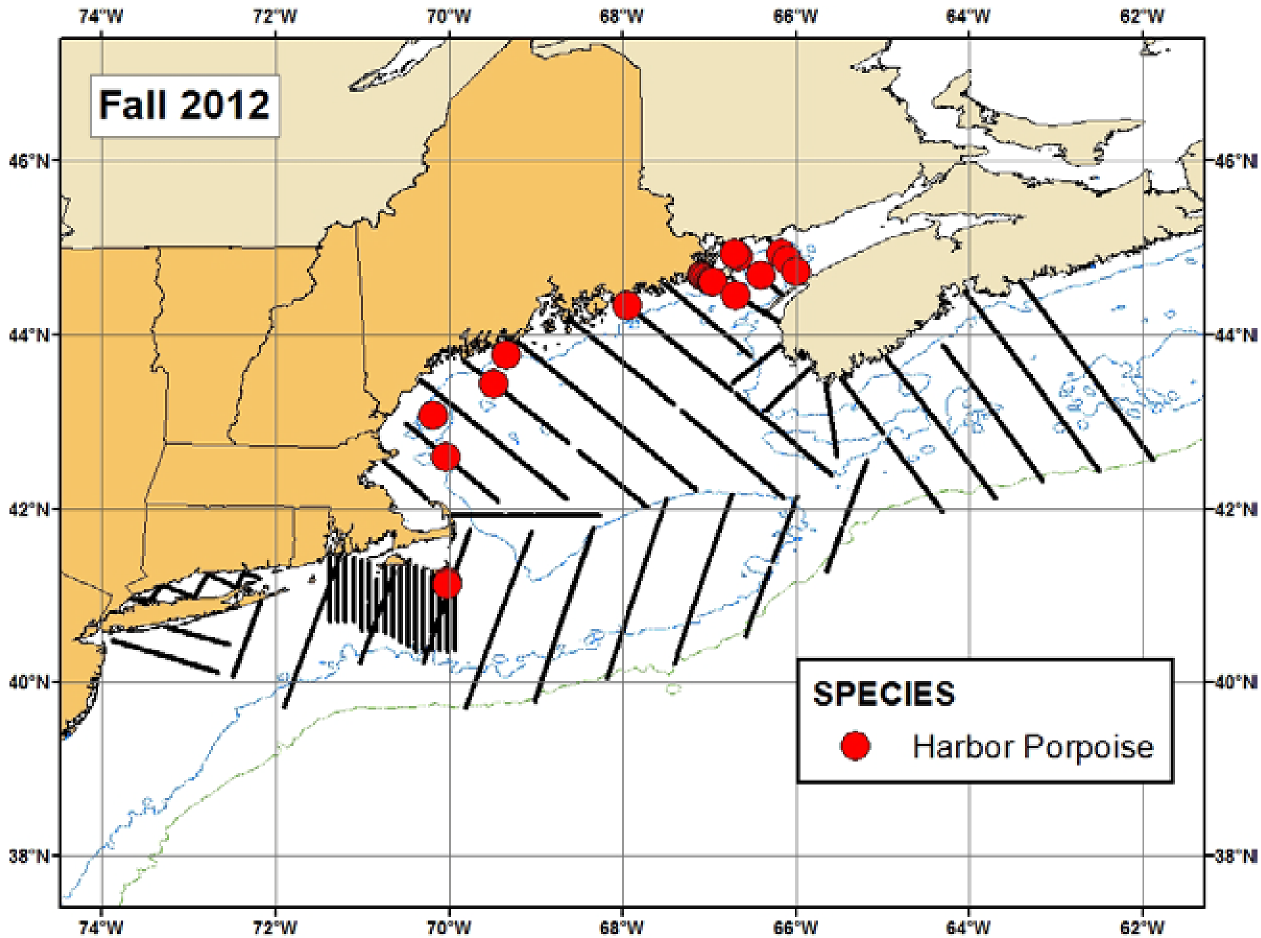


Figure A11. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): Locations of common dolphins (purple), white-sided dolphins (brown), bottlenose dolphins (yellow) and groups that were either common or white-sided dolphins (green) as detected by the front team. 100 m and 2000 m depth contours shown.

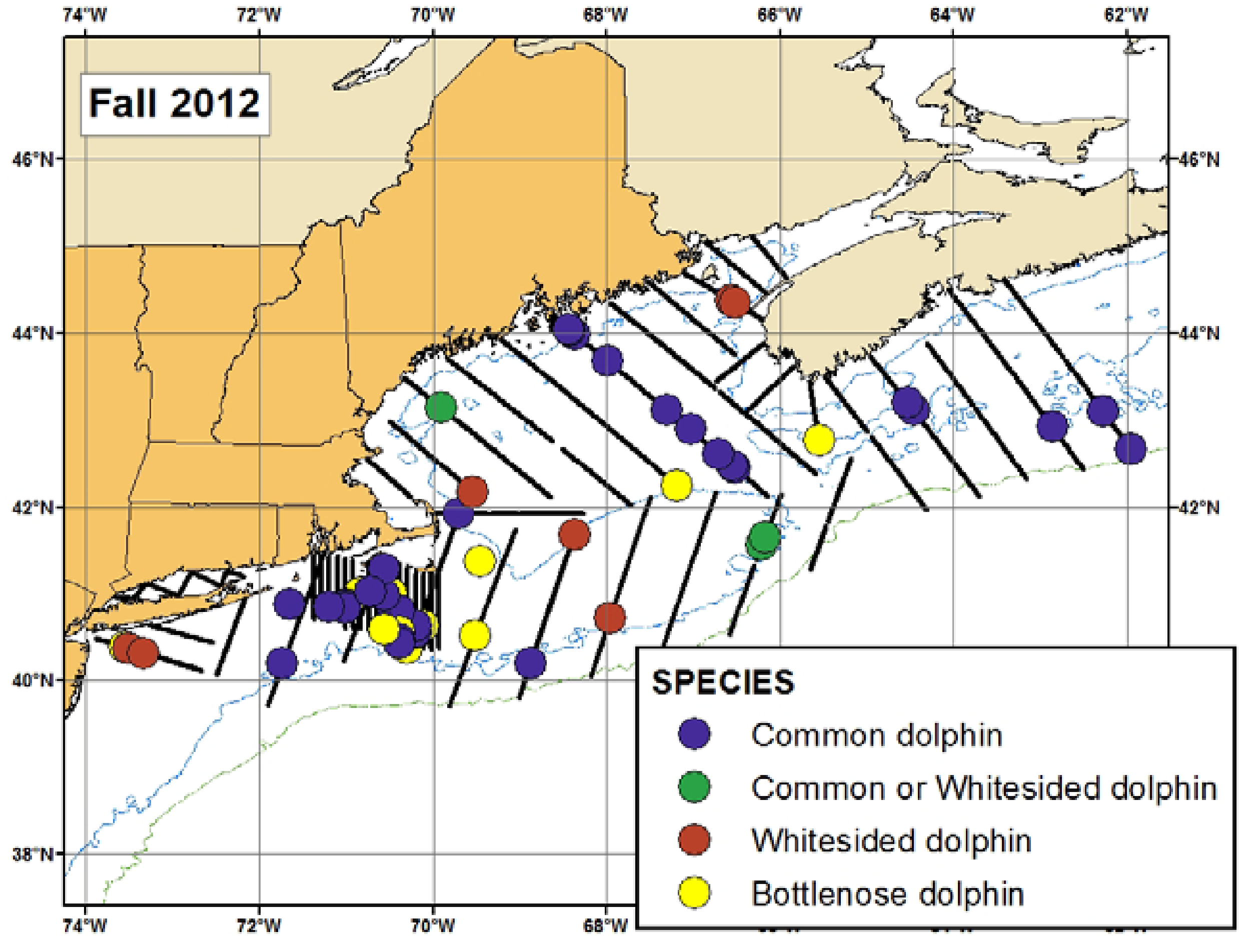


Figure A12. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): Locations of Risso's dolphins (yellow), pilot whales (green) and striped dolphins (red) detected by the front team. 100 m and 2000 m depth contours shown.

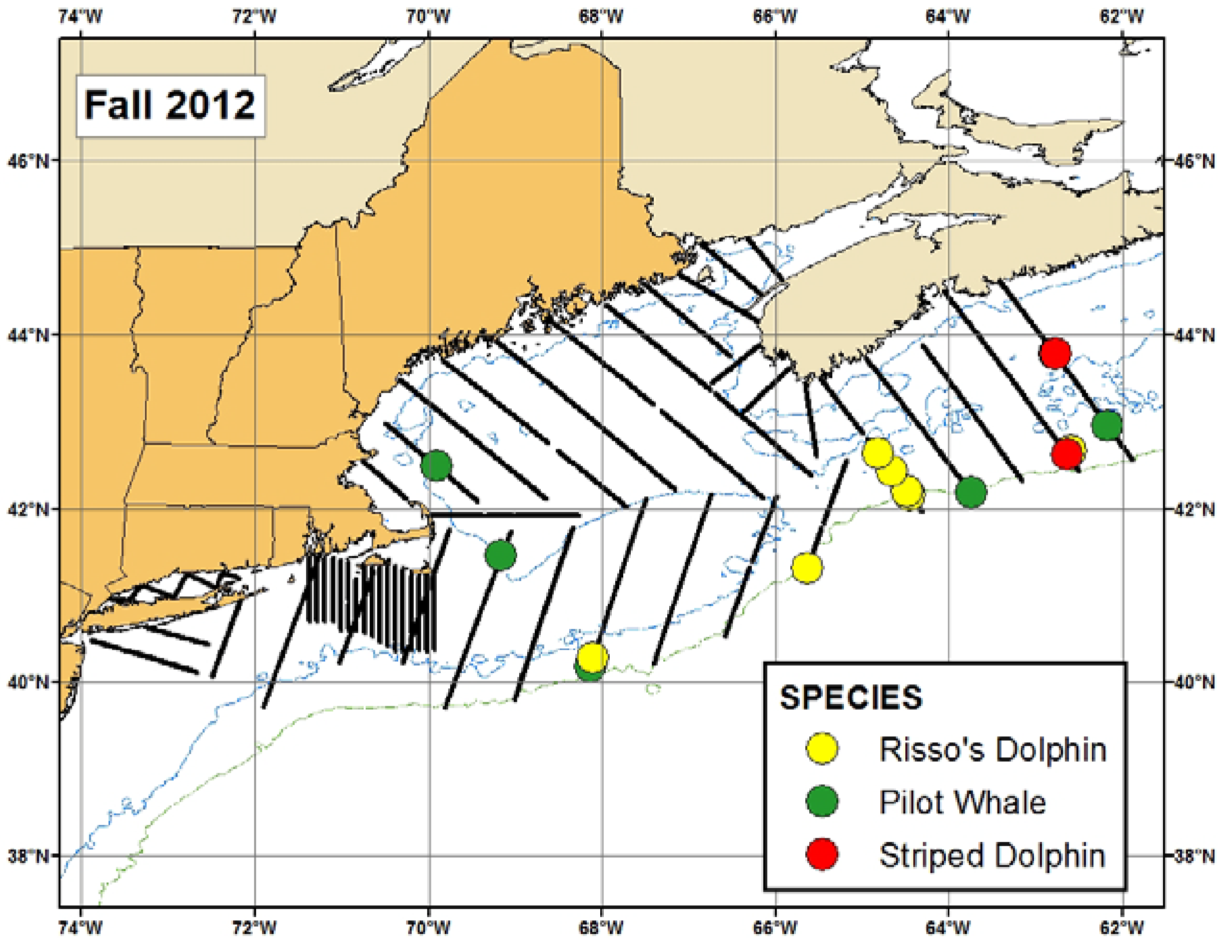


Figure A13. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): Locations of fin whales (blue), sei whales (brown) and groups that were either a fin or sei whale (green) detected by the front team. 100 m and 2000 m depth contours shown.

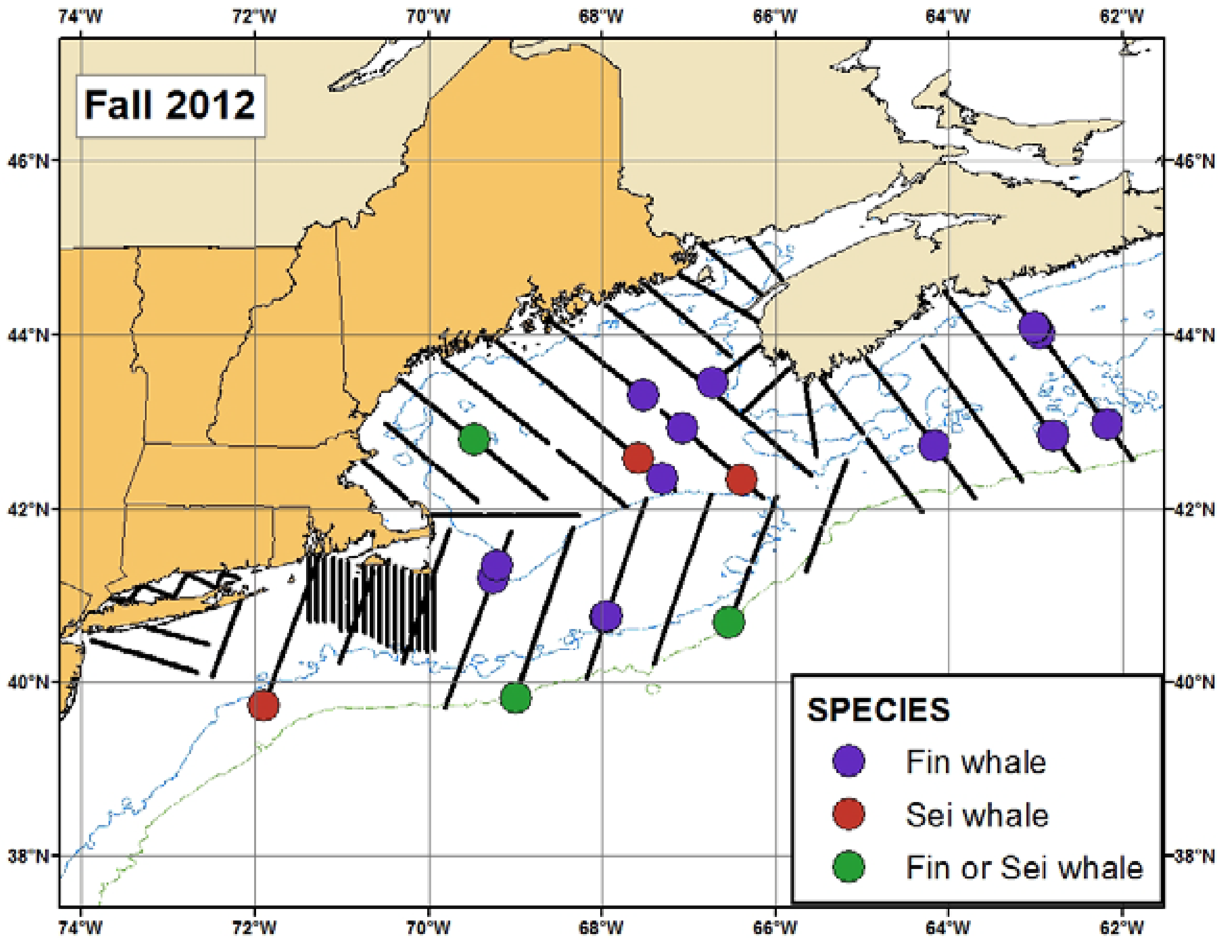


Figure A14. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): Locations of humpback whales (blue), minke whales (red), sperm whales (yellow) and unidentified whales (green) detected by the front team. 100 m and 2000 m depth contours shown.

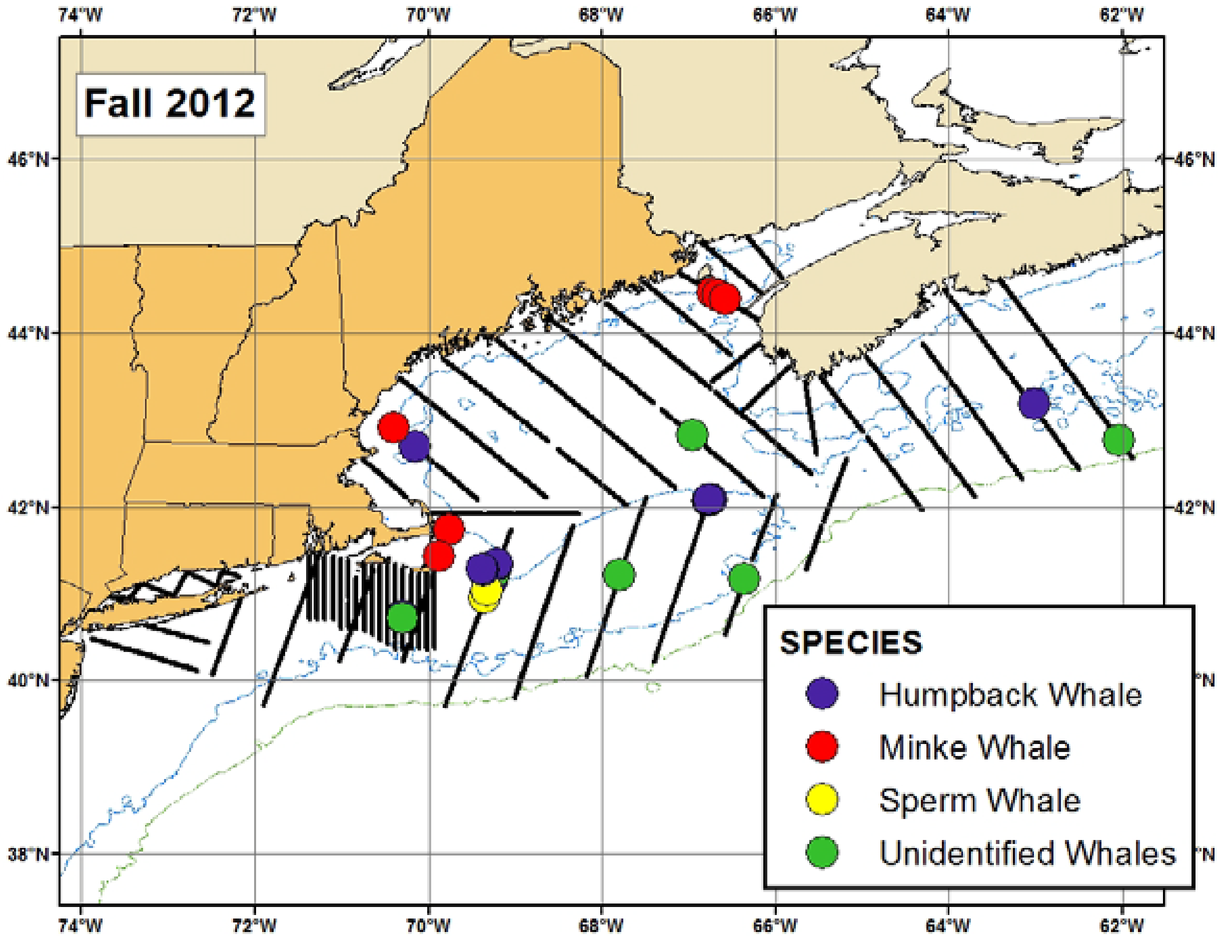


Figure A15. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): Locations of loggerhead turtles (brown), leatherback turtles (purple), green turtles (green) and unidentified hard shell turtles (blue) detected by the front team. 100 m and 2000 m depth contours shown.

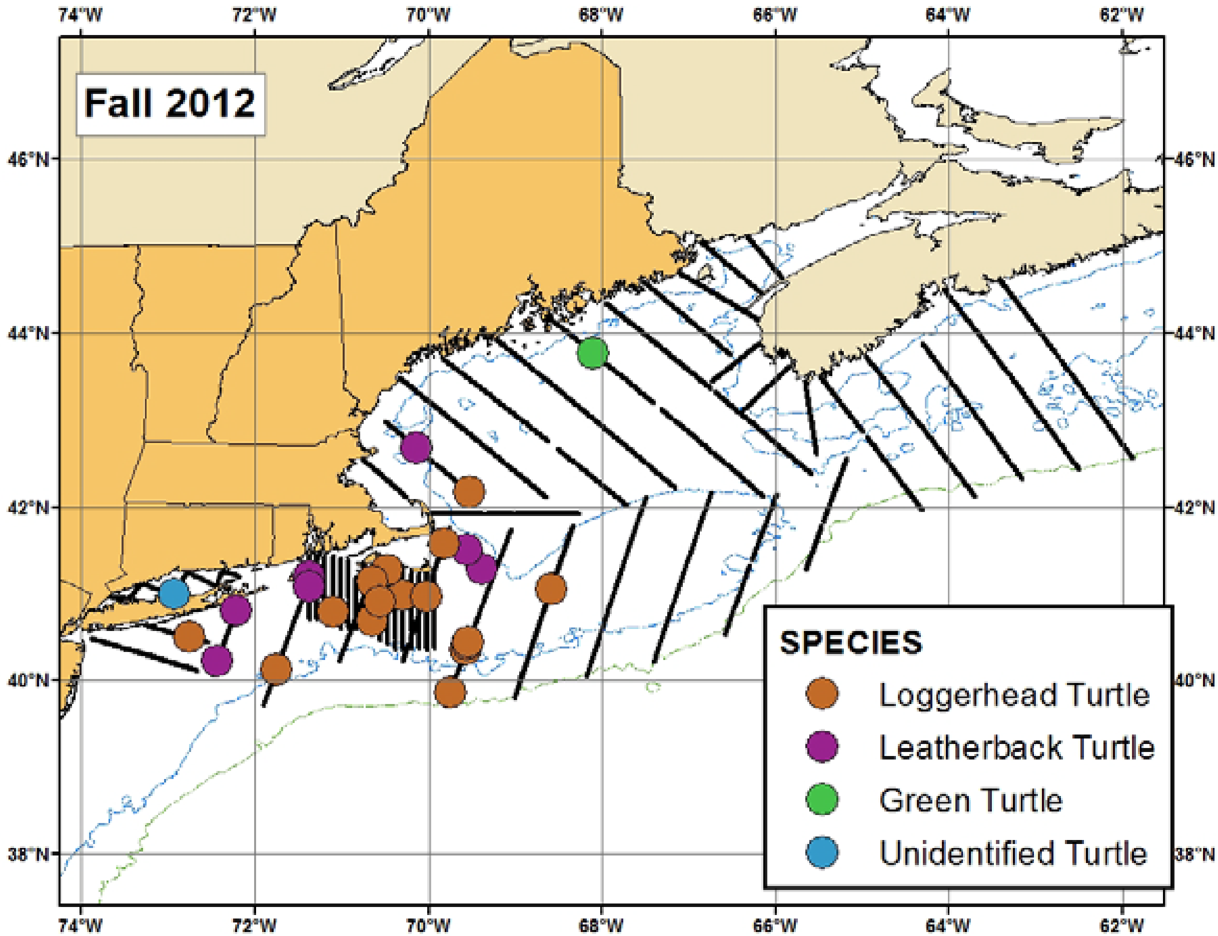


Figure A16. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): Locations of grey seals (blue), harbor seals (red) and unidentified seals (yellow) detected by the front team. 100 m and 2000 m depth contours shown.

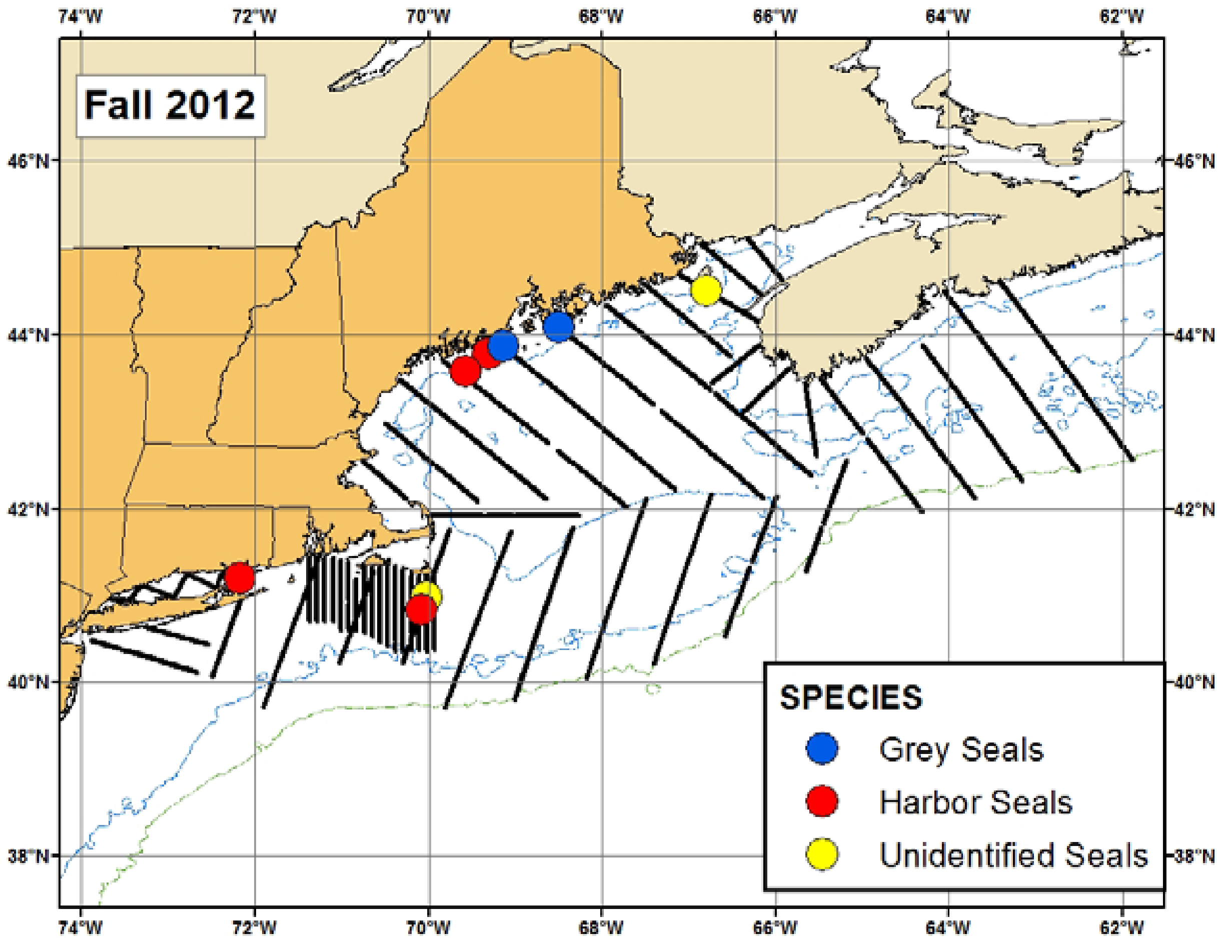
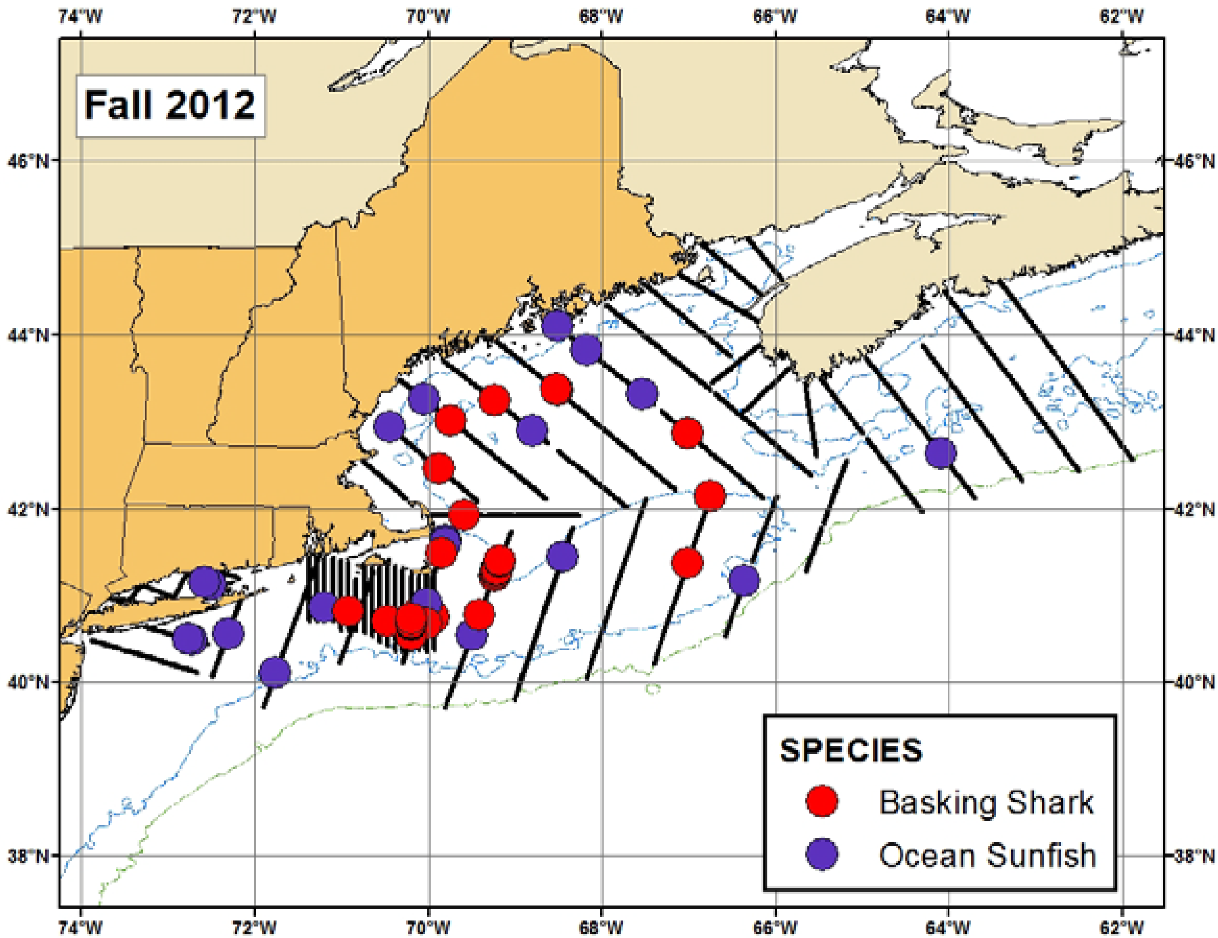


Figure A17. Fall 2012 Northeast AMAPPS aerial survey (17 October – 16 November 2012): Locations of basking sharks (red) and ocean sunfishes (blue) detected by the front team. 100 m and 2000 m depth contours shown.



Appendix B: *Southern leg of aerial abundance surveys during spring and fall 2012: Southeast Fisheries Science Center*

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SUMMARY

As part of the AMAPPS program, the Southeast Fisheries Science Center conducted aerial surveys of continental shelf waters along the US East Coast from Southeastern Florida to Cape May, New Jersey. Two surveys were conducted during 2012; a spring survey conducted during 3 April – 21 May and a fall survey conducted during 11 September – 16 October. The surveys were conducted along tracklines oriented perpendicular to the shoreline that were latitudinally spaced 20 km apart aboard a NOAA Twin Otter aircraft at an altitude of 600 feet (183 m) and a speed of 110 knots. The surveys were designed for analysis using Distance sampling and a two-team (independent observer) approach to correct for visibility bias in resulting abundance estimates. Both surveys also included "fine-scale" tracklines in waters offshore of New Jersey and Virginia. During the spring survey, a total of 11,252 km of trackline were surveyed on effort. Eleven species of marine mammals were identified, with the majority being bottlenose dolphins (130 groups sighted totaling 848 animals). Four species of sea turtles were identified, with the majority of the identified animals being loggerhead turtles (660 sightings totaling 751 animals). During the fall survey, 11,775 km of trackline were completed. Six species of marine mammals were identified, with the majority being bottlenose dolphins (148 groups sighted totaling 1,889 animals). Four species of sea turtles were identified, with the majority being loggerhead turtles (901 sightings totaling 1,048 animals). The data collected from these surveys will be analyzed to estimate the abundance and spatial distribution of mammals and turtles along the US east coast.

OBJECTIVES

The goal of these surveys was to conduct line-transect surveys using the Distance sampling approach to estimate the abundance and spatial distribution of marine mammals and turtles in waters over the continental shelf (shoreline to 200 m isobaths) from Southeastern Florida to Cape May, New Jersey.

CRUISE PERIOD AND AREA

Spring survey

The spring survey was conducted during 3 April – 21 May 2012. The study area extended from Cape May, New Jersey to the southeastern tip of Florida, from the coast line to about the 200 m depth contour (Figure B1).

Fall survey

The fall survey was conducted during 11 September – 16 October 2012. The study area extended from Cape May, New Jersey to the southeastern tip of Florida, from the coast line to about the 200 m depth contour (Figure B2).

METHODS

The survey was conducted aboard a DeHavilland Twin Otter DHC-6 flying at an altitude of 183m (600 ft) above the water surface at a speed of approximately 200 kph (110 knots). Surveys were typically flown only when wind speeds were less than 20 knots or approximately sea state 4 or less on the Beaufort scale. The survey was conducted along tracklines oriented perpendicular to the shoreline and spaced latitudinally at approximately 20 km intervals from a random start point (Figures B1 – B2). Offshore of Virginia and New Jersey within designated “Wind Areas”, fine-scale tracklines were flown that were spaced 5 km apart.

There were two pilots and six scientists onboard the airplane. The scientists operated as two teams to implement the independent observer approach to correct for visibility bias (Laake and Borchers 2004). The forward team (Team 1) consisted of two observers stationed in bubble windows on either side of the airplane and an associated data recorder. The bubble windows allowed downward visibility including the trackline. The aft team (Team 2) consisted of a belly observer looking straight down through a belly port, an observer stationed on one side of the aircraft observing through a large window, and a dedicated data recorder. The side bubble window observer was stationed in a large “vista” window that provided trackline visibility while the belly observer can see approximately 35 degrees on either side of the trackline. Therefore, the aft team has limited visibility of the left side of the aircraft. The two observer teams operated on independent intercom channels so that they were not able to cue one another to sightings.

Data was entered by each team’s data recorded onto a laptop computer running data acquisition software that recorded GPS location, environmental conditions entered by the observer team (e.g., sea state, water color, glare, sun penetration, visibility, etc.), effort information, and surface water temperature.

During on effort periods (e.g., level flight at survey altitude and speed), observers searched visually from the trackline (0°) to approximately 50° above vertical. When a turtle, mammal, or other organism was observed, the observer waited until it was perpendicular to the aircraft and then measured the angle to the organism (or the center of the group) using a digital inclinometer or recorded the angle in 10° intervals based upon markings on the windows. The belly observer only reported the interval for the sighting. Fish species were recorded opportunistically.

Sea turtle sightings were recorded independently, without communication, by each team. For marine mammal sightings, if the sighting was made initially by the forward team, they waited until it was aft of the airplane to allow the aft team an opportunity to observe the group before notifying the pilots to circle over the group. Once both teams had the opportunity to observe the group, the observers asked the pilots to break effort and circle the group. The aircraft circled over the majority of the marine mammal groups sighted to verify species identification and group sizes and to take photographs. The data recorders indicated at the time of the sighting whether or not the group was recorded by one or both teams.

The turtle data will be reviewed to identify duplicate sightings by the two teams based upon time, location, and position relative to the trackline.

RESULTS

Spring Survey

The survey was conducted during 3 April – 21 May, 2012, but survey flights could only be conducted on 11 days during that period due to weather conditions, mechanical issues, or transits between cities. A total of 11,252 km of trackline were covered on effort along 132 tracklines (Figure B1, Table B1). The average sea state during the survey was 2.6 on the Beaufort scale with the vast majority of the survey effort flown in sea states of 2 or 3 (Figure B3). However, some sections of trackline, particularly the outer portion of tracklines, were flown in higher sea states.

There were a total of 1,414 unique sightings of sea turtles for a total of 1,578 individuals. Turtles were identified as loggerhead turtles, green turtles, Kemp's ridley turtles, leatherback turtles, and unidentified hardshells (Table B2). Of these, the majority of identified turtle sightings were loggerhead turtles (Figure B4). The highest concentration of turtle sightings occurred north of Cape Canaveral, FL and along the North Carolina coast (Figures B4 – B6).

There were a total of 290 groups of marine mammals sighted for a total of 1,794 individuals. The primary species observed was bottlenose dolphins. Large whales including right whales, humpback whales, minke whales and fin whales were seen in the northern portion of the survey area (Table B3, Figures B7 – B9).

Fish species sighted included primarily sharks, rays, and sunfish (Figure B10).

Fall Survey

The survey was conducted during 11 September – 16 October, 2012, but survey flights could only be conducted on 19 days during that period due to weather conditions, mechanical issues, or transits between cities. A total of 11,775 km of trackline were covered on effort along 140 tracklines including fine-scale tracklines in wind energy areas offshore of New Jersey and Virginia (Figure B2, Table B4). The average sea state during the survey was 2.3 on the Beaufort scale with the vast majority of the survey effort flown in sea states of 2 or 3 (Figure B11). However, some sections of trackline, particularly the outer portion of tracklines, were flown in higher sea states. There were gaps in survey coverage in the southern portion of the survey range due to weather conditions and limited available flight days.

There were a total of 1,821 sightings of sea turtles for a total of 2,087 individuals. Turtles were identified as loggerhead turtles, green turtles, Kemp's ridley turtles, leatherback turtles, and unidentified hardshells (Table B5). Of these, the majority of turtle sightings were loggerhead turtles (Figure B12). The highest concentration of turtle sightings occurred north of Cape Canaveral and in areas offshore north of Cape Hatteras (Figures B12 – B14).

There were a total of 241 groups of marine mammals sighted for a total of 2,757 individuals. The primary species observed was bottlenose dolphins. A diverse group of species including pilot whales, common dolphins, and fin whales were observed along the shelf break north of North Carolina (Table B6, Figures B15 – B17).

Fish species sighted included primarily sharks, rays, and sunfish (Figure B18).

DISPOSITION OF DATA

All data collected during these surveys will be maintained by Dr. Lance Garrison at SEFSC in Miami, FL and are available from the NEFSC's Oracle database.

PERMITS

SEFSC was authorized to conduct the research activities during this survey under Permit No. 779-1633-00 issued to the SEFSC by the NMFS Office of Protected Resources. Sea turtle sightings were permitted under ESA Section 10a1a permit #1551 issued to the SEFSC.

ACKNOWLEDGEMENTS

The funds for this project came from the Bureau of Ocean Energy Management (BOEM) and the US Navy through the respective Interagency Agreements for the AMAPPS project. Staff time was also provided by the NOAA Fisheries Service, SEFSC and NOAA Aircraft Operations Center (AOC). We would also like to thank the pilots and observers involved in collecting the spring and fall 2012 aerial surveys.

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Table B1. Daily summary of survey effort and protected species sightings during Southeast AMAPPS spring 2012 aerial survey.

Date	Effort (km)	Marine mammal sightings	Turtle sightings	Average sea state
4/03/2012	92.9	0	0	4.4
4/04/2012	847.0	45	7	2.1
4/05/2012	508.2	15	1	2.3
4/11/2012	246.8	1	0	4.3
4/13/2012	997.7	27	0	2.6
4/14/2012	614.0	12	0	3.7
4/21/2012	630.8	24	122	2.4
4/25/2012	836.0	22	22	2.8
4/27/2012	28.2	0	0	2.7
4/29/2012	444.4	4	11	3.2
4/30/2012	678.0	13	27	3.3
5/1/2012	547.5	8	43	2.4
5/2/2012	682.9	19	235	3.3
5/3/2012	431.0	14	53	2.5
5/4/2012	698.3	18	87	2.6
5/14/2012	542.2	13	73	3.0
5/15/2012	277.7	7	45	2.6
5/16/2012	60.2	4	52	1.9
5/17/2012	904.8	27	274	1.9
5/20/2012	828.8	13	290	2.0
5/21/2012	354.7	4	72	1.4
Total	**11,252.1**	**290**	**1414**	**2.6**

Table B2. Summary of sea turtle sightings during Southeast AMAPPS spring 2012 aerial survey.

Species	Number of sightings	Number of animals
Green turtle	43	45
Unidentified hardshell	629	689
Kemp's ridley	5	5
Leatherback	77	88
Loggerhead	660	751
Total	**1,414**	**1,578**

Table B3. Summary of marine mammal sightings during Southeast AMAPPS spring 2012 aerial survey.

Species	Number of groups	Number of animals
Atlantic spotted dolphin	21	184
Bottlenose dolphin	130	848
Bottlenose/Atl spotted dolphin	18	26
Common dolphin	43	43
Cuvier's beaked whale	2	3
Fin whale	7	12
Humpback whale	6	7
Minke whale	5	6
North Atlantic right whale	2	6
Pilot whale spp.	2	105
Risso's dolphin	19	85
Sperm whale	4	4
Stenella sp.	1	14
Unid. dolphin	27	432
Unid. Odonocete	2	18
Unid. large whale	1	1
Total	**290**	**1794**

Table B4. Daily summary of survey effort and protected species sightings during Southeast AMAPPS fall 2012 aerial survey.

Date	Effort (km)	Marine mammal sightings	Turtle sightings	Average sea state
9/11/2012	389.2	9	36	3.2
9/12/2012	1093.4	17	215	1.9
9/13/2012	1029.9	13	186	1.4
9/14/2012	1100.9	20	251	1.9
9/16/2012	549.3	10	152	2.0
9/17/2012	501.3	6	98	2.1
9/20/2012	42.3	0	1	3.7
9/21/2012	616.0	14	14	4.3
9/22/2012	512.8	13	22	1.7
9/26/2012	1230.8	28	37	2.0
9/27/2012	256.9	7	23	2.3
9/28/2012	741.8	19	69	2.5
10/3/2012	514.0	20	71	2.0
10/4/2012	228.9	6	93	1.6
10/7/2012	1041.1	29	213	2.1
10/8/2012	565.2	14	155	1.9
10/9/2012	304.2	2	56	3.5
10/15/2012	578.1	8	43	3.1
10/16/2012	479.0	6	86	3.4
Total	**11,775.1**	**241**	**1,821**	**2.3**

Table B5. Summary of sea turtle sightings during Southeast AMAPPS fall 2012 aerial survey.

Species	Number of sightings	Number of animals
Green turtle	18	19
Unidentified hardshell	774	884
Kemp's ridley	17	18
Leatherback	111	118
Loggerhead	901	1048
Total	**1,821**	**2,087**

Table B6. Summary of marine mammal sightings during Southeast AMAPPS fall 2012 aerial survey.

Species	Number of groups	Number of animals
Atlantic spotted dolphin	24	242
Bottlenose dolphin	148	1889
Bottlenose/Atl spotted dolphin	18	85
Common dolphin	3	89
Fin whale	6	10
Pilot whale spp.	16	268
Risso’s dolphin	2	47
Unid. baleen whale	1	2
Unid. dolphin	21	122
Unid. Odonocete	1	2
Unid. large whale	1	1
Total	**241**	**2,757**

Figure B1. Aerial survey tracklines during the Southeast AMAPPS spring 2012 aerial survey.

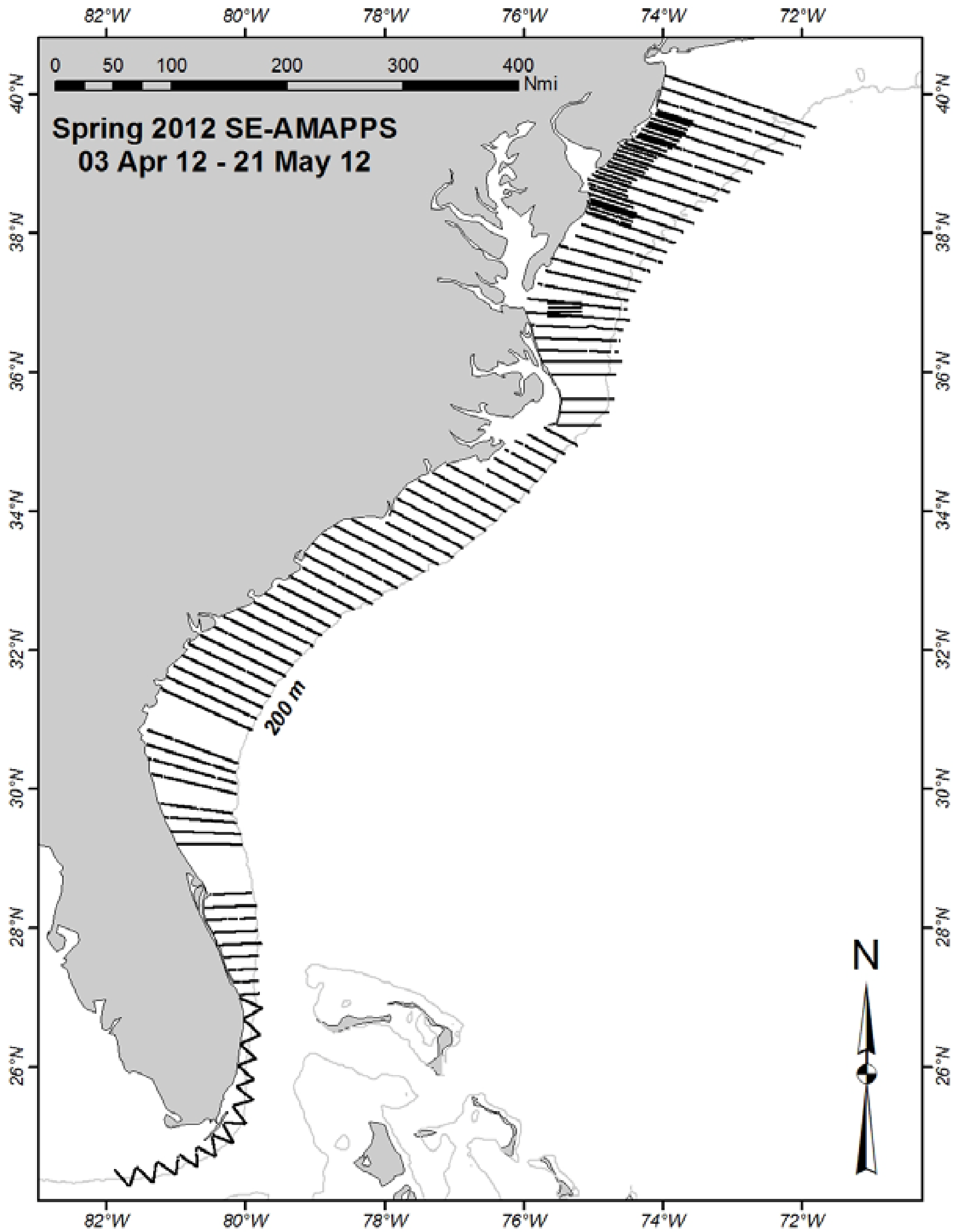


Figure B2. Aerial survey tracklines during the Southeast AMAPPS fall 2012 aerial survey.

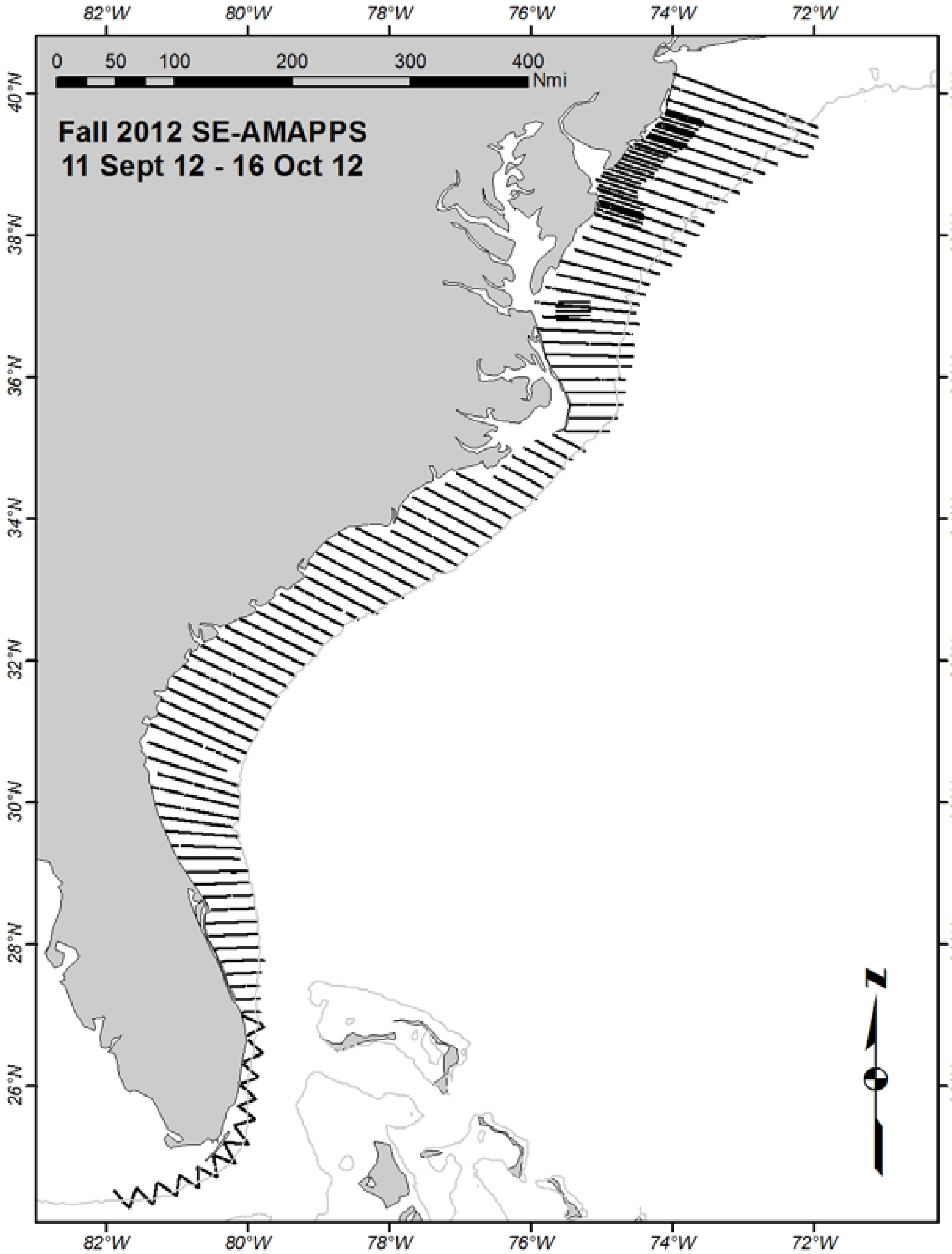


Figure B3. Beaufort sea states during the Southeast AMAPPS spring 2012 aerial survey.

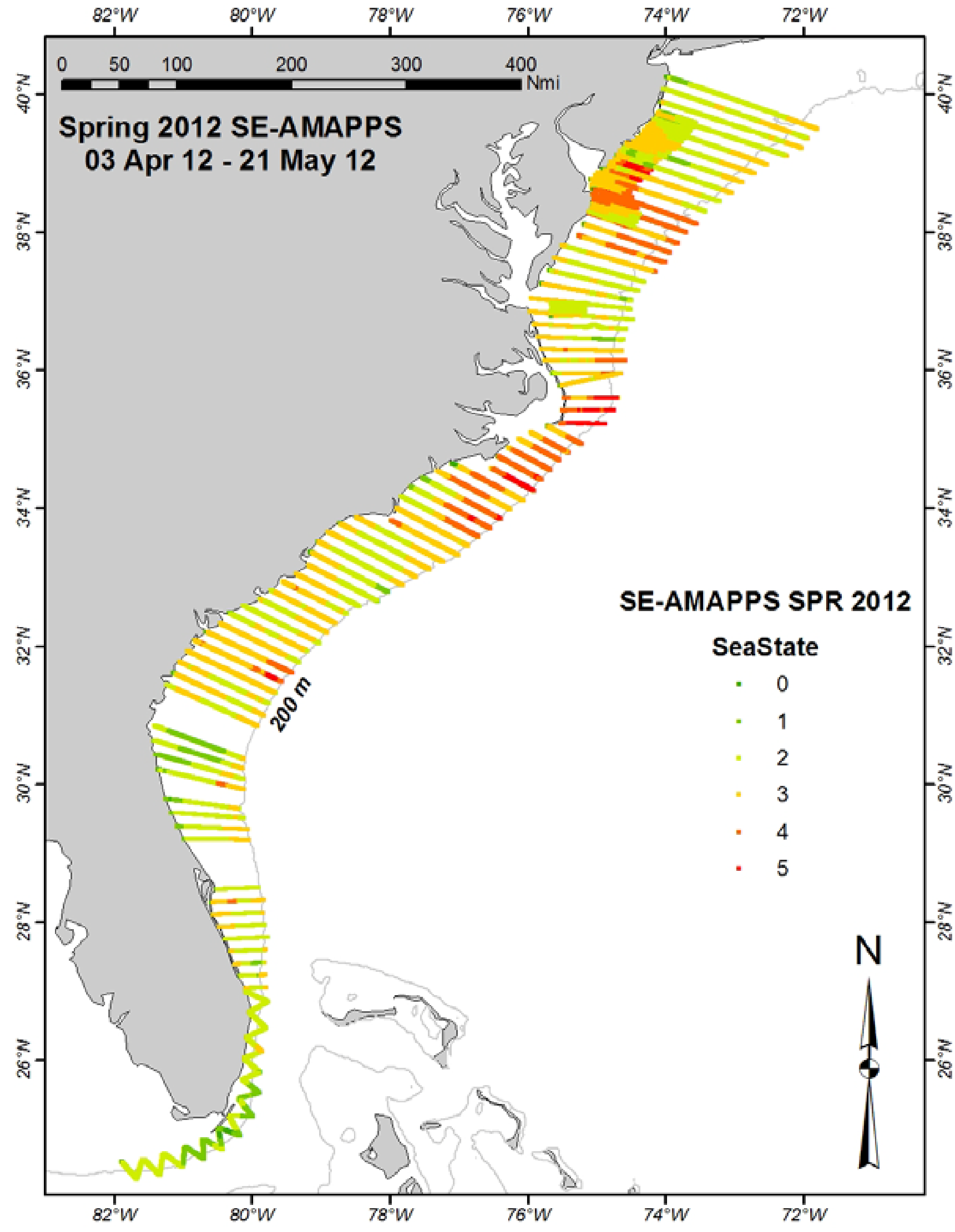


Figure B4. Loggerhead turtle sightings during the Southeast AMAPPS spring 2012 aerial survey.

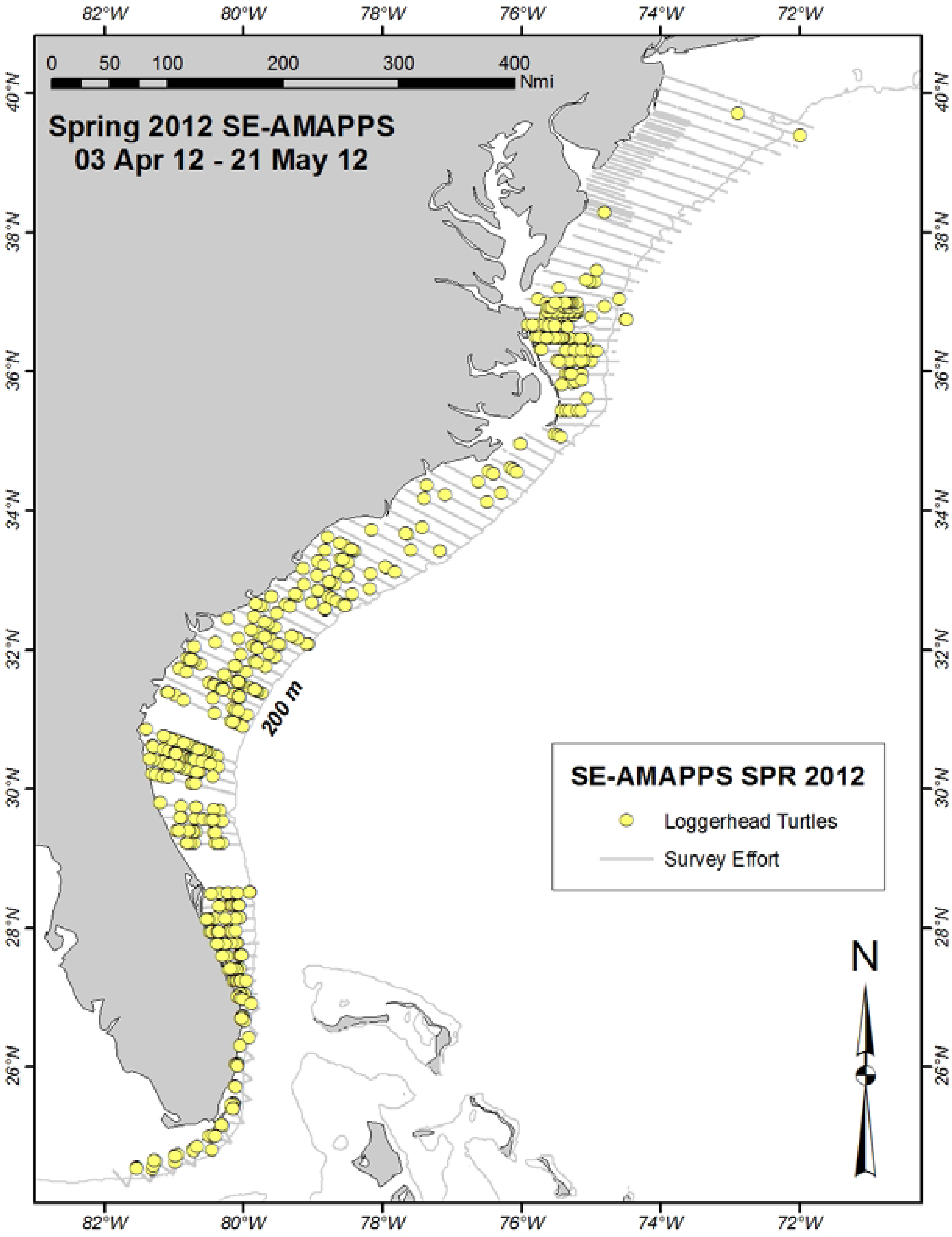


Figure B5. Other hardshell turtle sightings during the Southeast AMAPPS spring 2012 aerial survey.

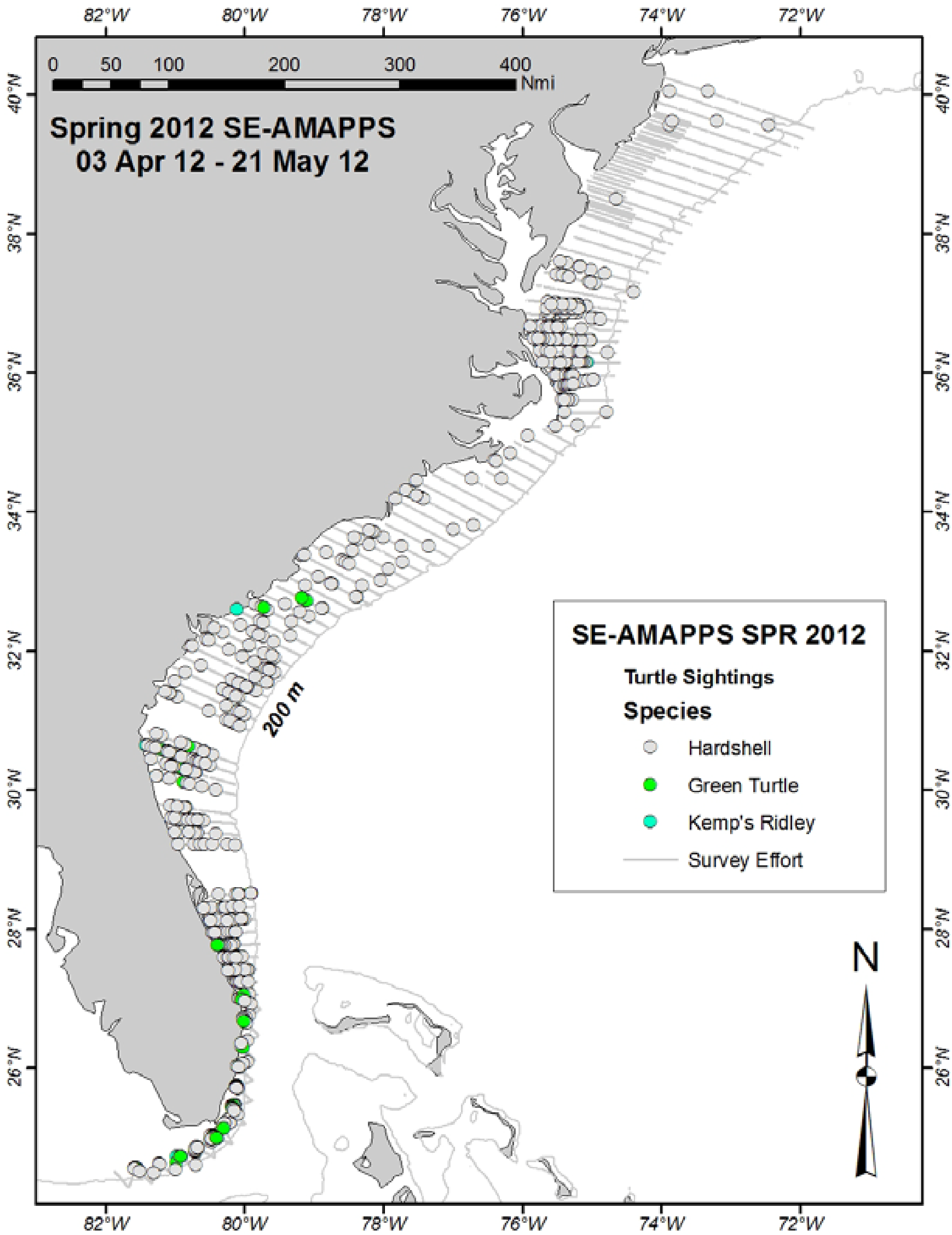


Figure B6. Leatherback turtle sightings during the Southeast AMAPPS spring 2012 aerial survey.

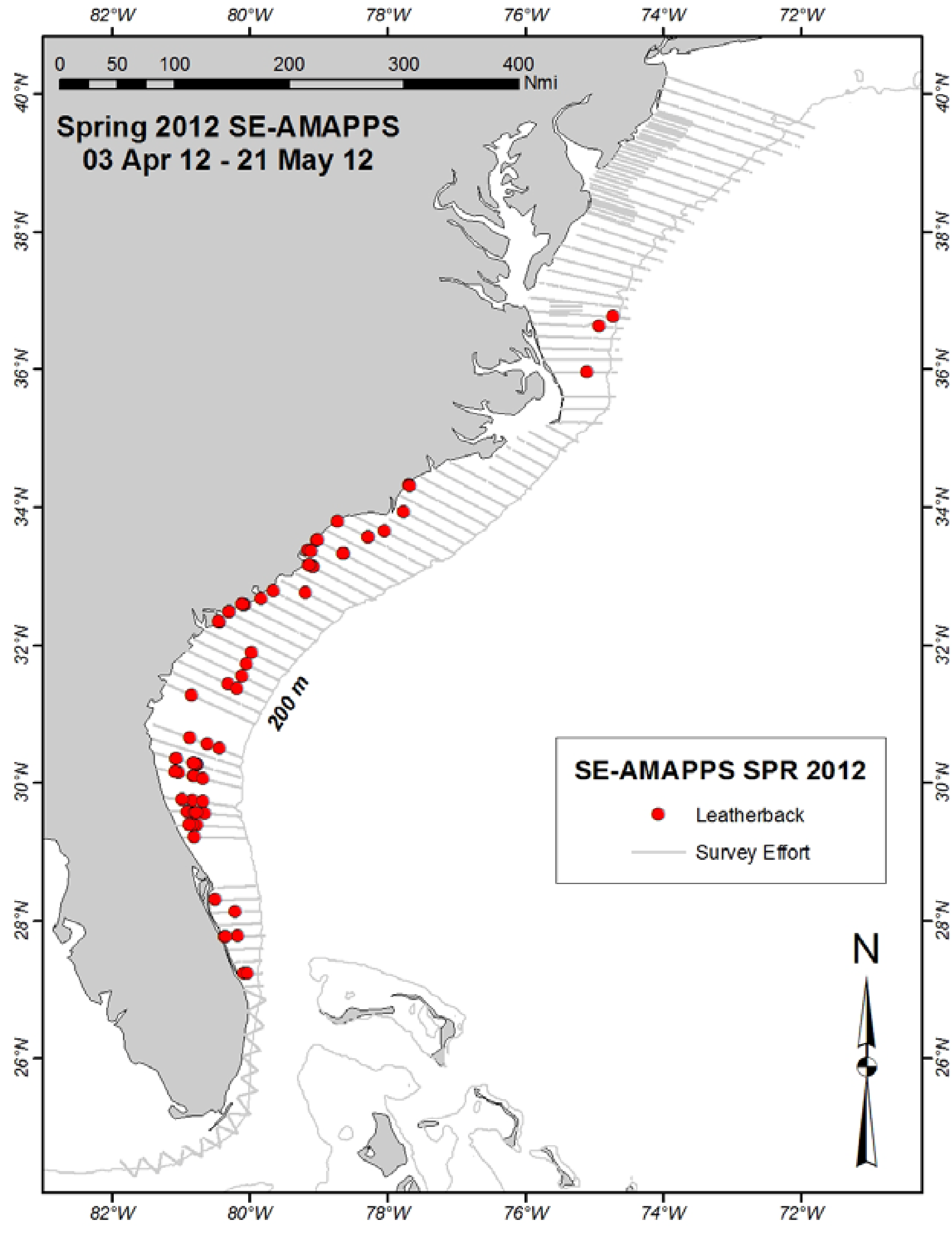


Figure B7. Bottlenose dolphin sightings during the Southeast AMAPPS spring 2012 aerial survey.

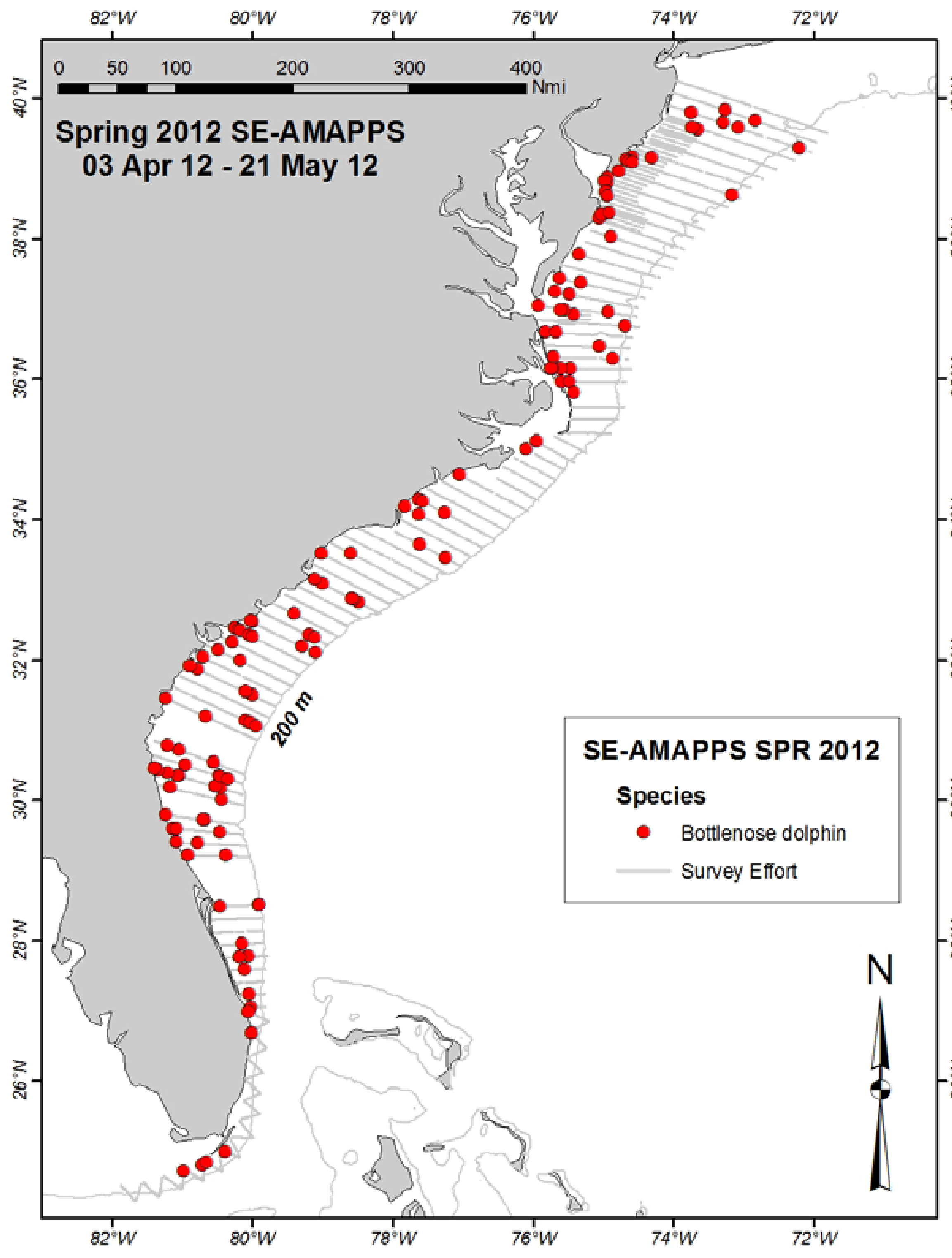


Figure B8. Other dolphin sightings during the Southeast AMAPPS spring 2012 aerial survey.

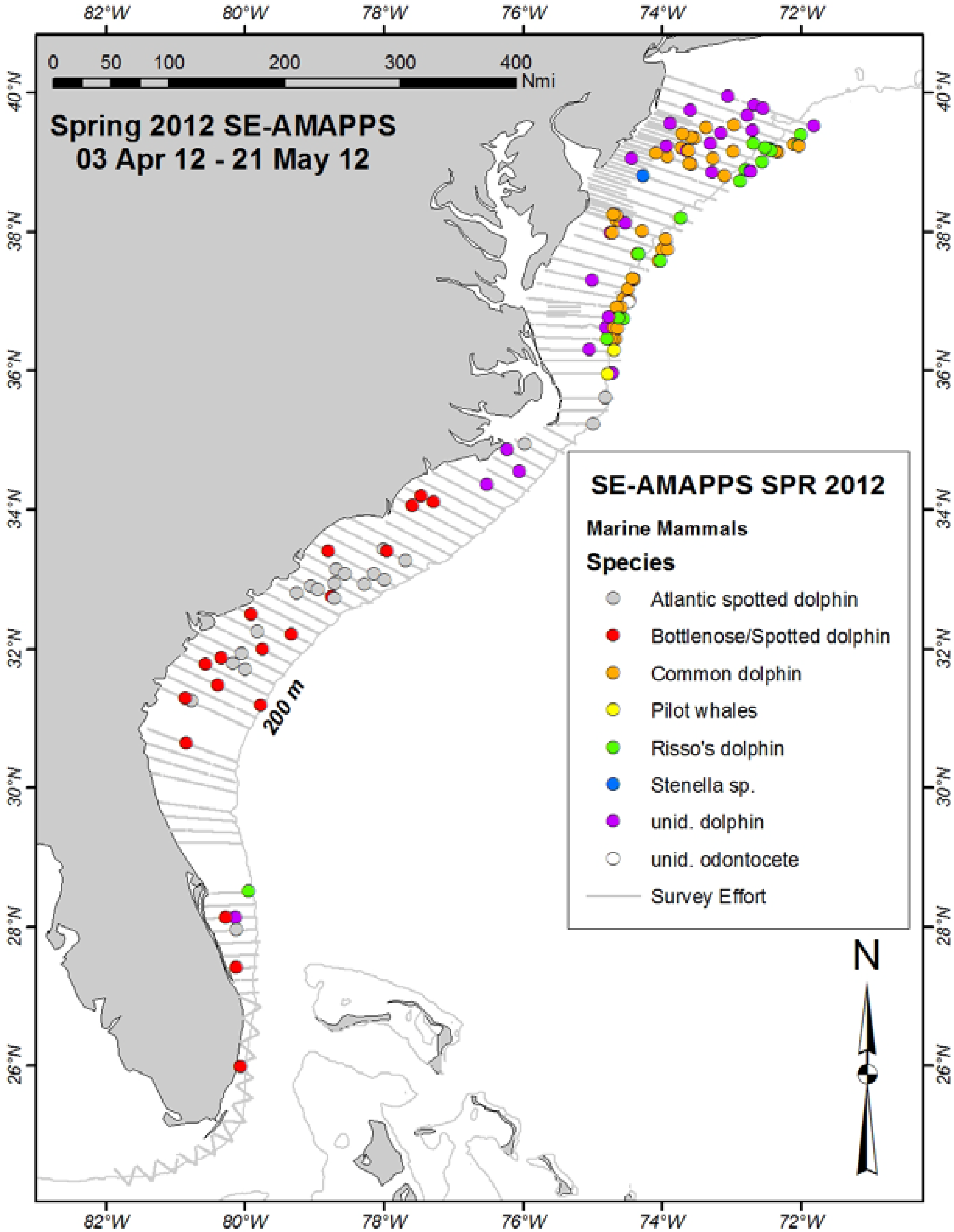


Figure B9. Whale sightings during the Southeast AMAPPS spring 2012 aerial survey.

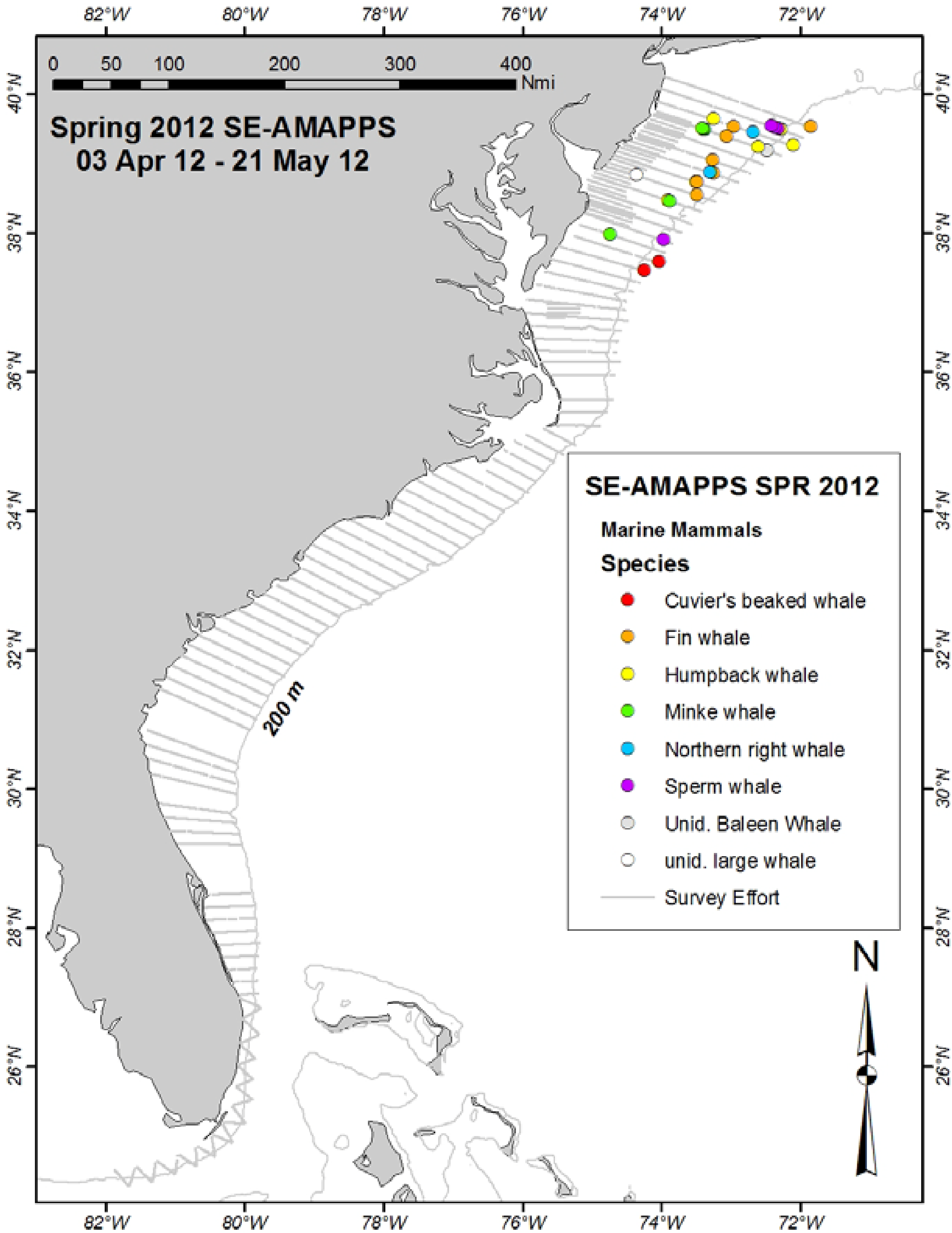


Figure B10. Fish sightings during the Southeast AMAPPS spring 2012 aerial survey.

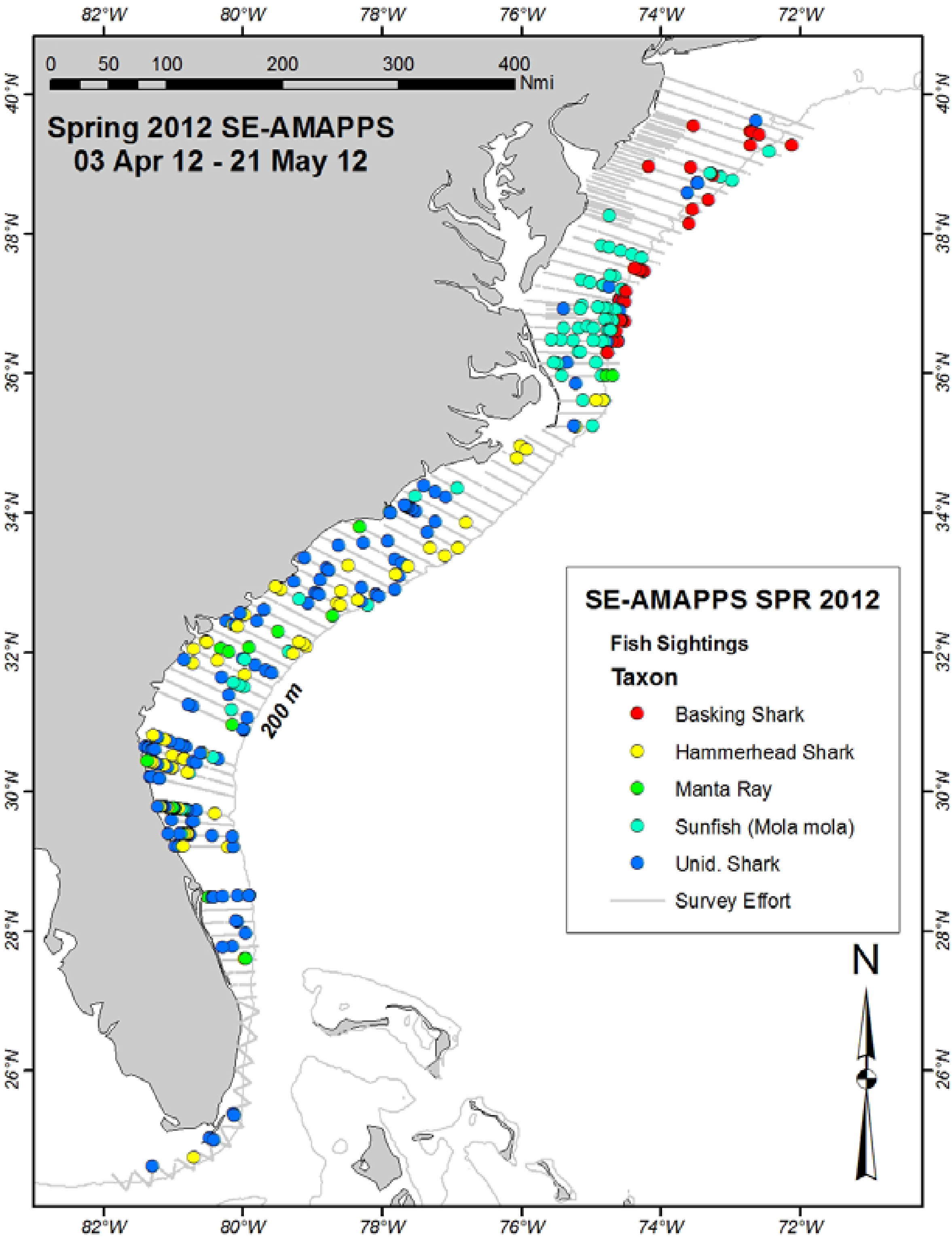


Figure B11. Beaufort sea states during the Southeast AMAPPS fall 2012 aerial survey.

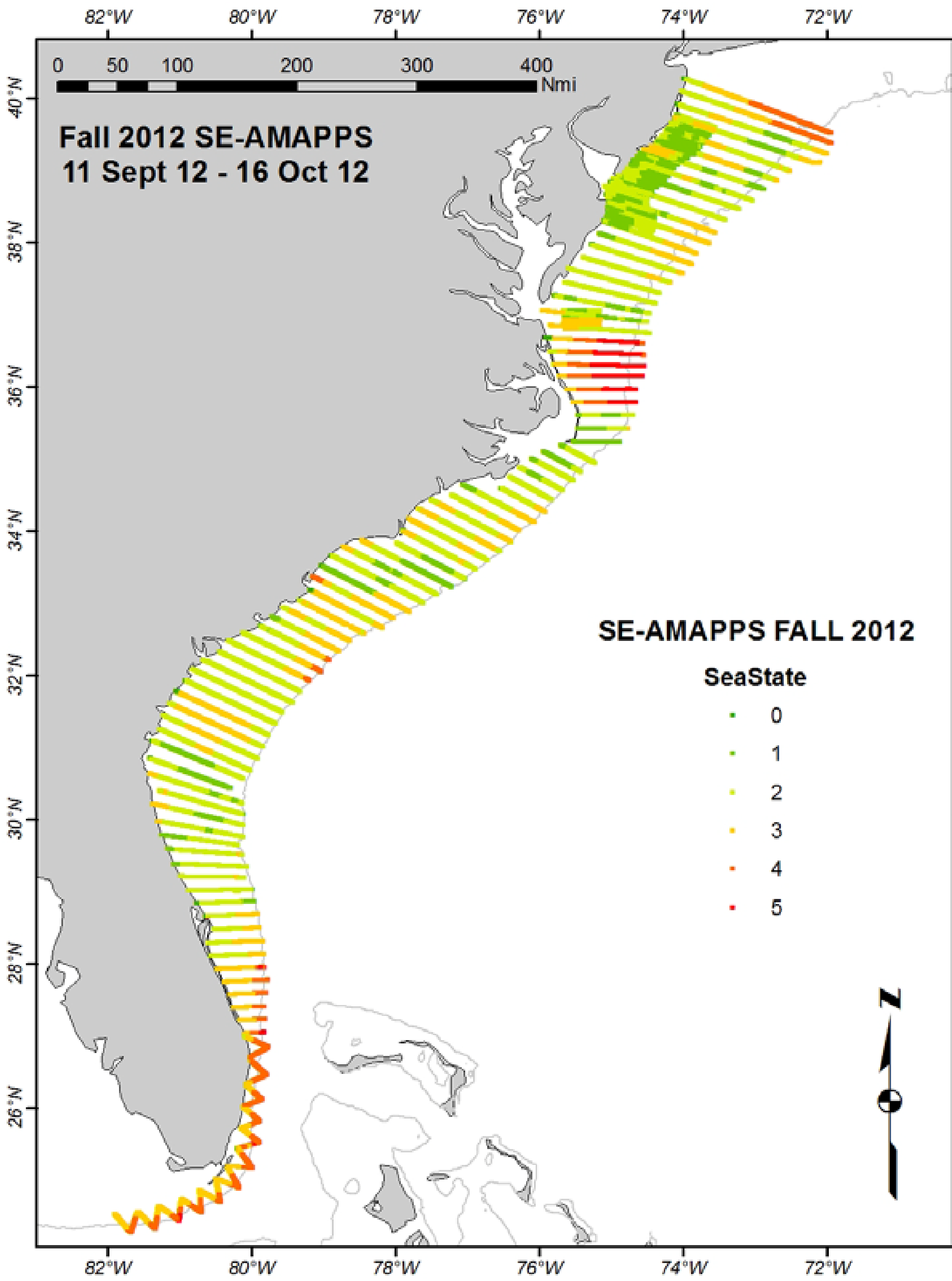


Figure B12. Loggerhead turtle sightings during the Southeast AMAPPS fall 2012 aerial survey.

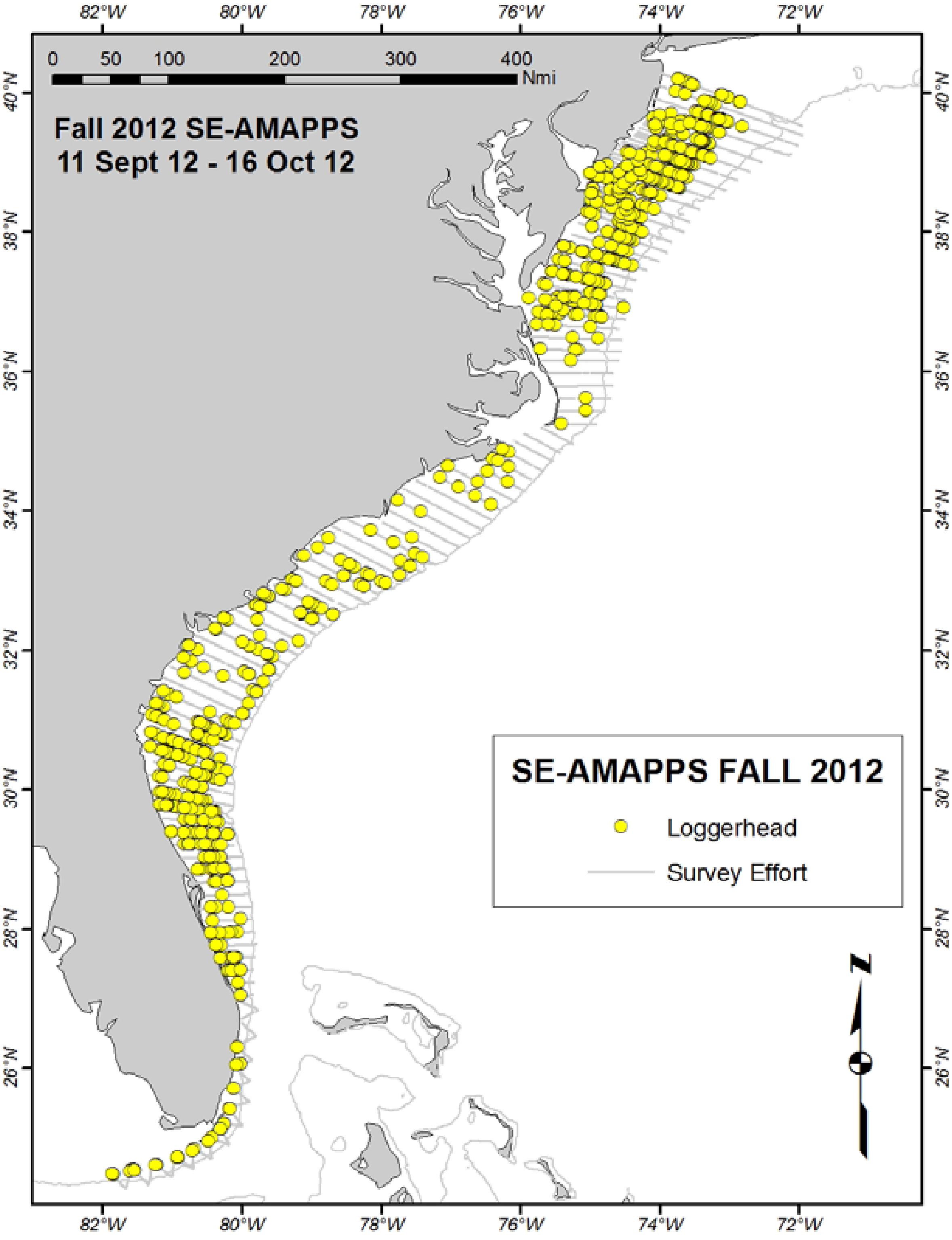


Figure B13. Other hardshell turtle sightings during the Southeast AMAPPS fall 2012 aerial survey.

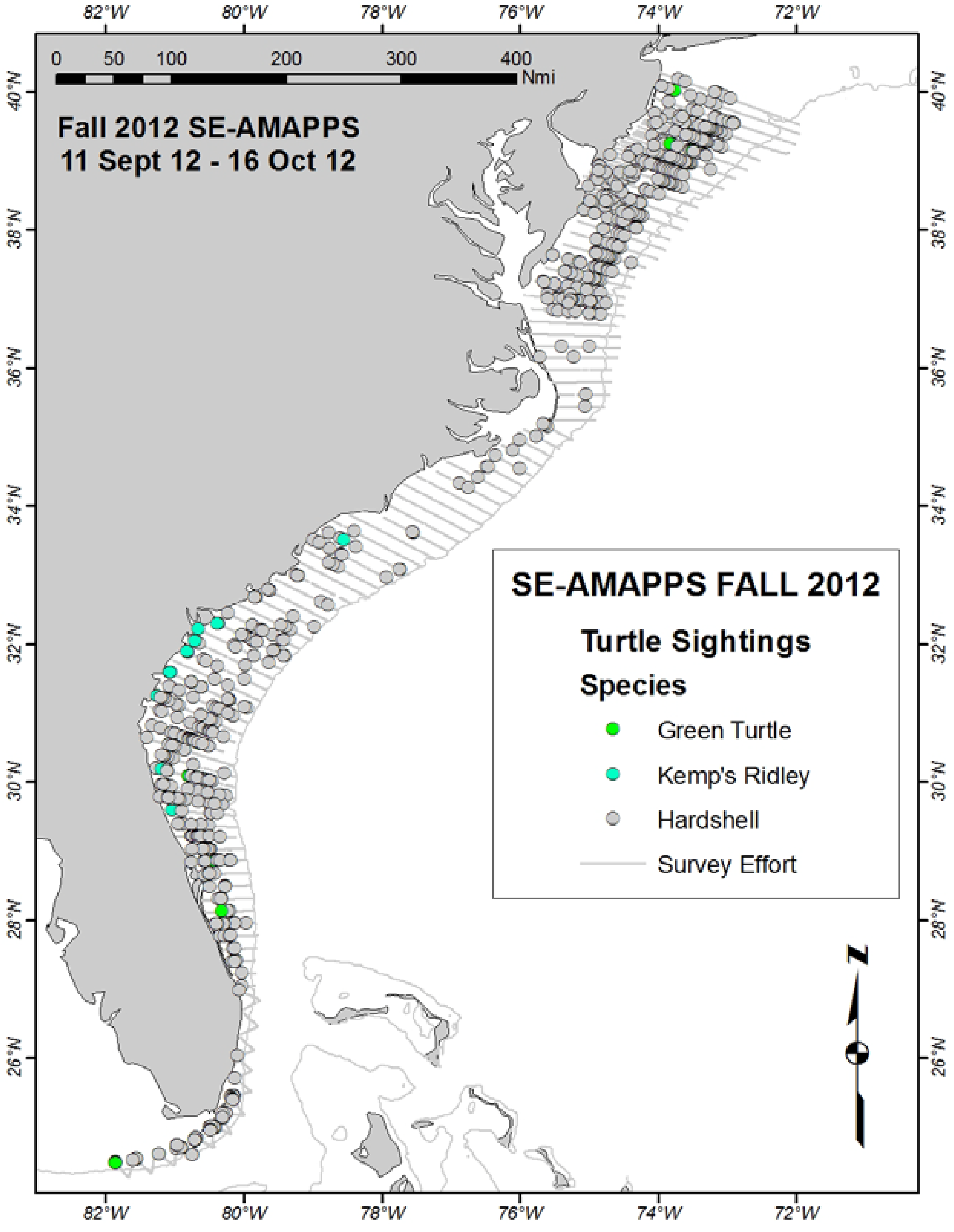


Figure B14. Leatherback turtle sightings during the Southeast AMAPPS fall 2012 aerial survey.

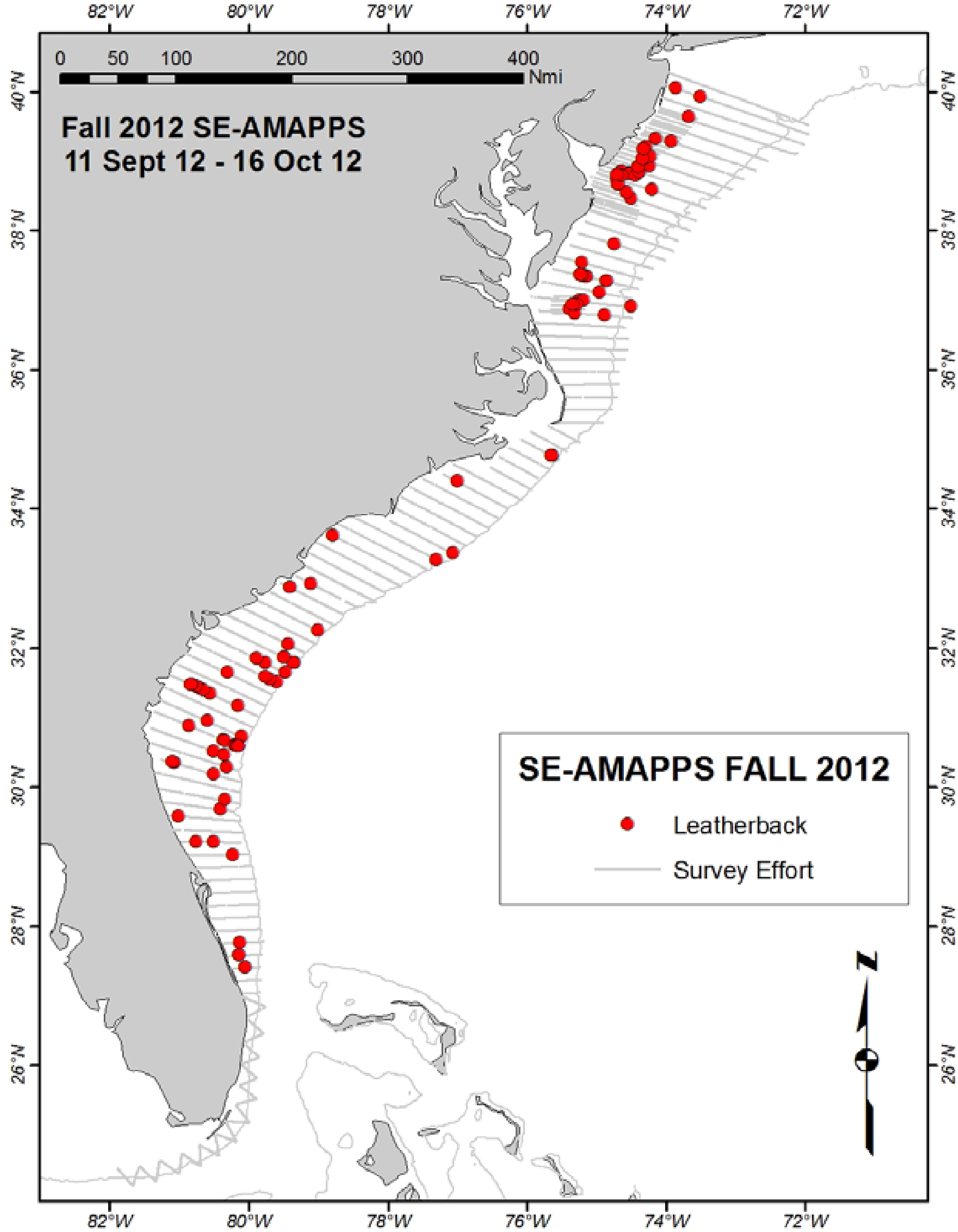


Figure B15. Bottlenose dolphin sightings during the Southeast AMAPPS fall 2012 aerial survey.

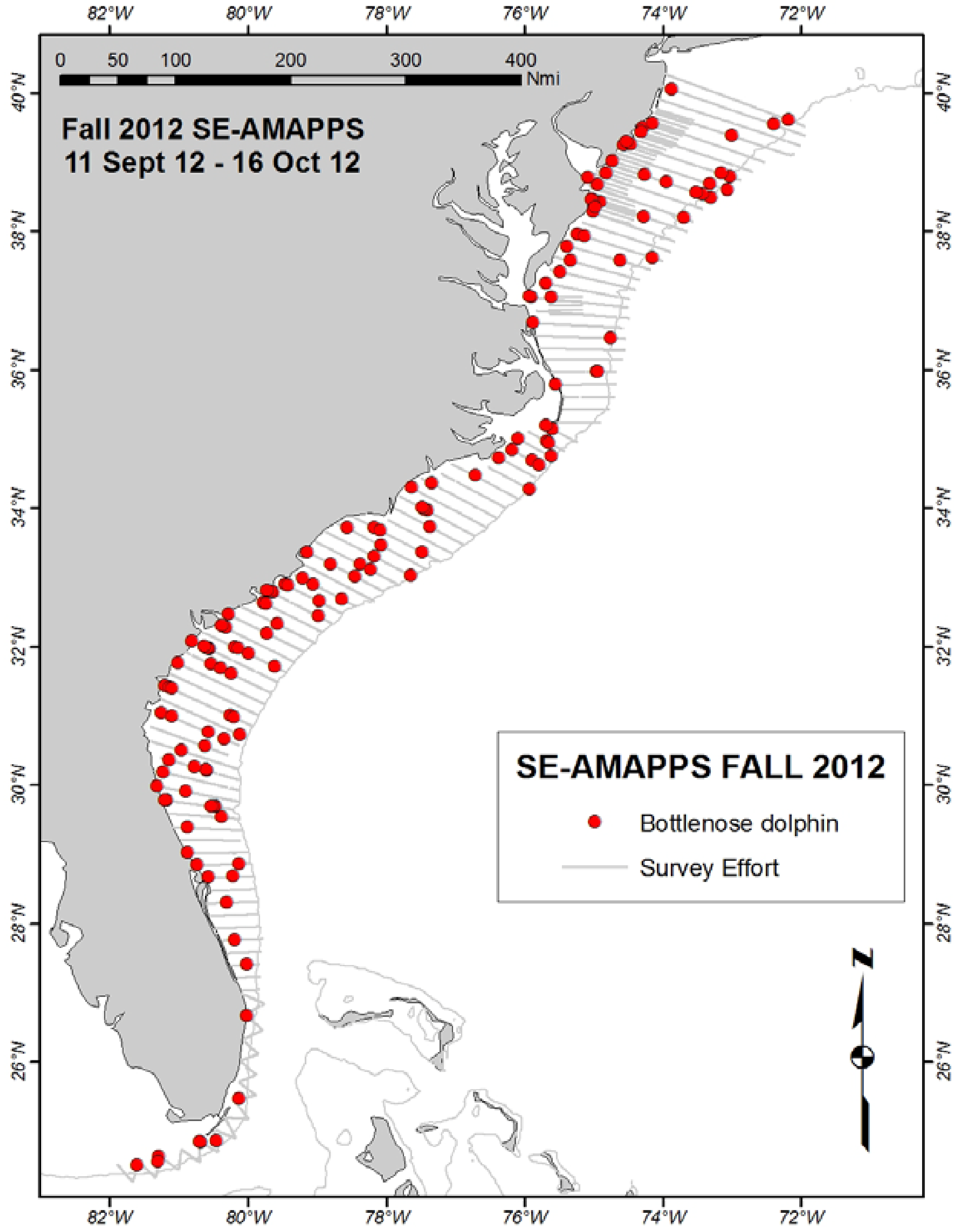


Figure B16. Other dolphin sightings during the Southeast AMAPPS fall 2012 aerial survey.

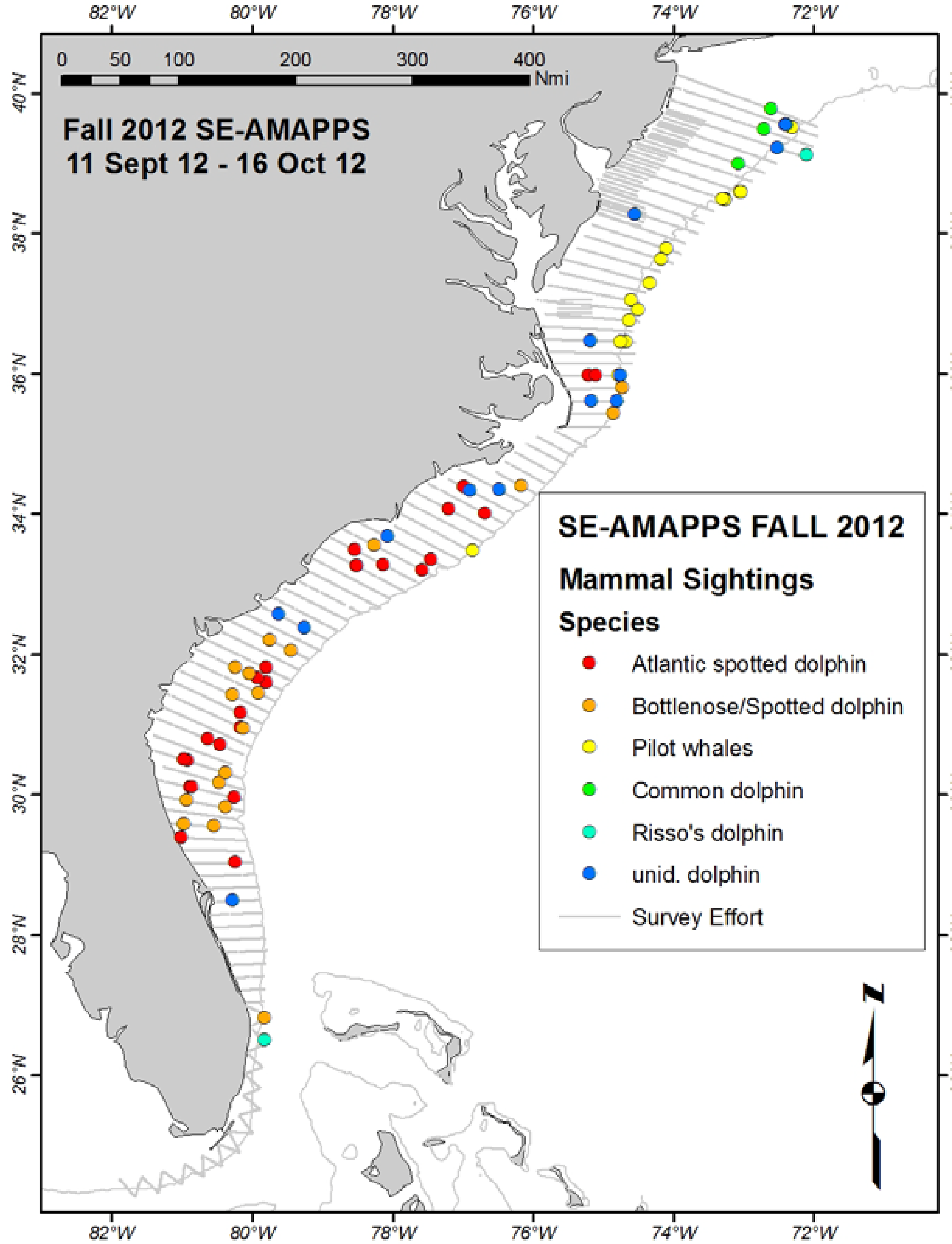


Figure B17. Whale sightings during the Southeast AMAPPS fall 2012 aerial survey.

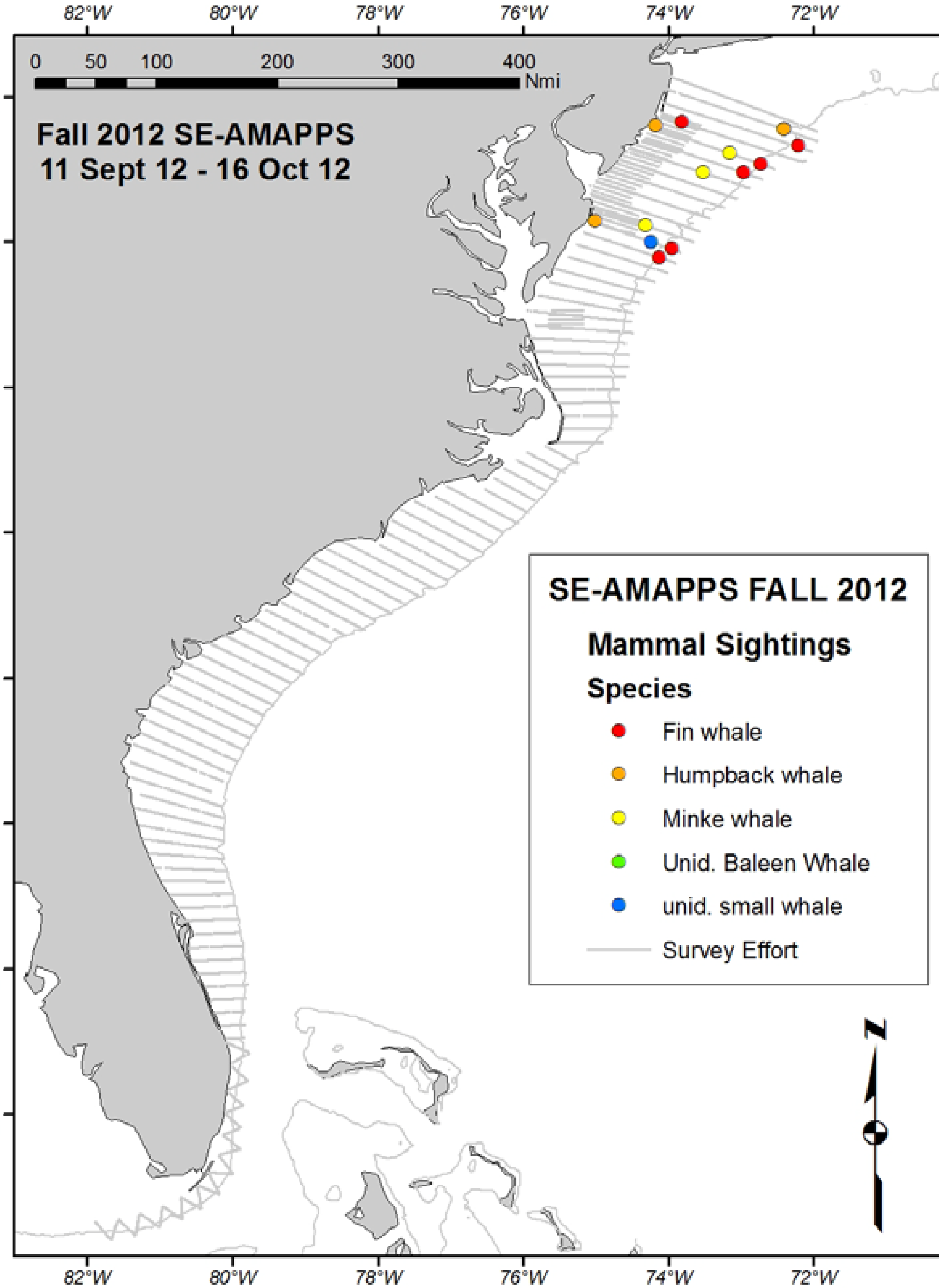
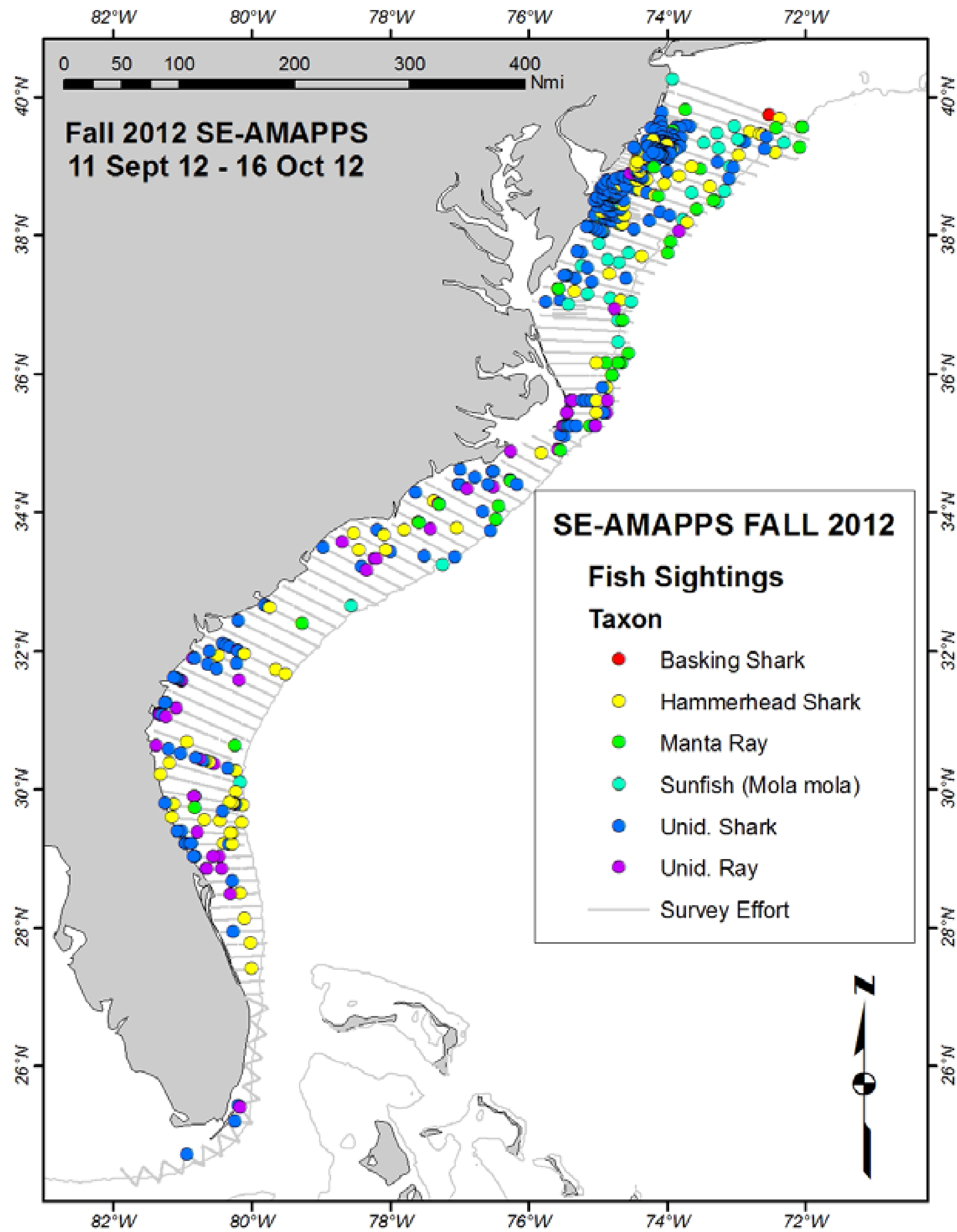


Figure B18. Fish sightings during the Southeast AMAPPS fall 2012 aerial survey. These reflect sightings by the forward team.



Appendix C: *Northern Sea Turtle Tagging Project: Northeast Fisheries Science Center*

Heather Haas[1] and Ron Smolowitz[2]

[1] Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA 02543
[2] Coonamessett Farm Foundation

SUMMARY

Loggerhead turtles (*Caretta caretta*) have been biologically sampled and tagged with Sea Mammal Research Unit's Fastloc GPS Satellite Relay Data Loggers to correct visual abundance estimates to account for availability bias and to provide additional information on habitat usage, life history, residence time and frequency of use. During 2012, 32 immature loggerhead sea turtles were captured primarily offshore of Delaware through Virginia and then sampled and satellite-tagged. This work was a joint effort of the Northeast Fisheries Science Center, Coonamessett Farm Foundation, Virginia Aquarium & Marine Science Center, and the National Marine Life Center. Biological sampling included measurements of the length, width, and weight of the animals, biopsy samples (for genetic analyses), and blood samples (to identify sex and assess the health of the animals). In addition, animals were photographed and tagged with flipper and PIT tags. As of November 2012, 25 tags were still transmitting. As of 3 December 2012 the Oracle database stores over 159,000 tag location records, 104,000 individual dive profiles, and 47,000 six-hour summaries of depth usage. In addition, a new webpage was developed (http://www.nefsc.noaa.gov/psb/turtles/turtleTracks.html) that shows the most recent (weekly) locations for all of the turtles tagged in 2012.

BACKGROUND AND OBJECTIVES

One of the goals of the AMAPPS (Atlantic Marine Assessment Program for Protected Species) initiative is to develop models and associated tools to provide seasonal, spatially-explicit density estimates of marine mammals, sea turtles, and seabirds in the western north Atlantic. To achieve this goal data are being collected on the seasonal distribution and abundance of these taxa using aerial and shipboard surveys conducted by scientists from the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. These surveys can result in abundance estimates of the animals that are near the surface, that is, detectable by the observers on the ships and planes.

Telemetry study data will then be used to develop corrections to the visual abundance estimates to account for availability bias and will provide additional information on habitat usage, life history, residence time and frequency of use. Data for the loggerhead turtle (*Caretta caretta*) telemetry study has been collected since 2010, thus allowing the documentation of inter-annual differences and ensuring sufficient sample sizes. The US Mid-Atlantic region is an important foraging ground for loggerhead sea turtles, but due to complications involved with locating and capturing immature turtles on their foraging grounds, relatively little is known about the turtles that occupy the Mid-Atlantic continental shelf region.

In May and June 2012, under the partnership of AMAPPS, the NEFSC, Coonamessett Farm Foundation and others deployed 30 satellite tags on loggerhead sea turtles captured in offshore continental shelf Mid-Atlantic waters and 2 satellite tags in nearshore Mid-Atlantic waters. We also have plans in place to deploy in May of 2013 an additional 12 tags in nearshore Mid-

Atlantic waters using funds from FY12. In addition, one satellite tag was transferred to the AMAPPS seal program.

METHODS

Our collaborations allowed us to greatly increase the information gained from our field work. NEFSC and Coonamessett Farm Foundation (CFF) with the assistance of Viking Village Fisheries partnered together to accomplish the AMAPPS goals. NEFSC provided staff, 15 satellite tags, ARGOS time, and supplies. CFF provided 15 satellite tags, ARGOS time, the vessels, crew, and several at-sea scientific personnel. We also partnered with the Virginia Aquarium & Marine Science Center who provided equipment and at-sea scientific personnel. The Southeast Fisheries Science Center named the NEFSC as a co-investigator under their permit so that our expanded sampling could be covered by their ESA Permit #1551. We also collaborated with the National Marine Life Center and the Virginia Aquarium & Marine Science Center to include blood collection in our sampling suite.

On the evening of 30 May 2012 the F/Vs Kathy Ann and Ms. Manya (commercial scallop fishing vessels) departed from Barnegat Light, New Jersey with 10 scientific crew and 7 vessel crew to locate loggerheads in an area known to have overlap between large immature and adult loggerheads and commercial fishing activity (primarily 40 – 80 miles offshore of Delaware through Virginia). When turtles were located, we deployed small boats (14 ft) to capture the loggerheads using a large dipnet.

All captured loggerheads were transferred to the F/V Kathy Ann for biological sampling. In 2012 we completed basic sampling (measured the length and width of captured turtles, photographed, flipper and PIT tagged, and took biopsy samples for genetic analysis) plus we also measured weight and body depth, took biopsy samples for stable isotope analysis, and took blood samples to analyze for testosterone levels (to identify sex) and general blood chemistry (for health assessment).

In addition to the biological sampling we used epoxy to attach Sea Mammal Research Unit's (SMRU) Fastloc GPS Satellite Relay Data Loggers (SRDLs) to a central carapace scute of each captured turtle. The satellite tags were programmed to transmit every day, though local conditions often prevent the tags from transmitting. Specifications for the SMRU Fastloc GPS Satellite Relay Data Loggers (SRDLs) are provided in Appendix C1. The Fastloc GPS supplies highly accurate locations. The tag also uses precision wet/dry, pressure, and temperature sensors to form individual dive records (maximum depth, shape, and time at depth, etc.) along with temperature profiles and binned summary records. Since 2011 we also have variables to assess the average duration of a surfacing bout and average duration of a diving bout. The SMRU tag stores information in its memory and then relays an unbiased sample of detailed individual dive records and summary records. Data from all the tags are being uploaded weekly into a Northeast Sea Turtle Collaborative sea turtle tagging Oracle database, maintained by the NEFSC.

RESULTS

Together with our partners primarily offshore of Delaware through Virginia, we captured and satellite-tagged 32 immature loggerhead sea turtles (64 - 106 cm curved carapace length (CCL)). The location information for each tag (as of 3 December 2012) is shown in Figure C1. As of November 2012, 25 tags were still transmitting.

The detailed GPS location, temperature, and dive data are downloaded daily to a password-protected SMRU website and are uploaded weekly to a NEFSC Oracle database.

DISPOSITION OF DATA

By combining our data from previous year and with those provided by the Coonamessett Farm Foundation, as of 3 December 2012 the Oracle database stores over 159,000 location records, 104,000 individual dive profiles, and 47,000 six-hour summaries of depth use.

During 2012 we also implemented a new webpage showing the most recent (weekly) locations for all of the turtles tagged in 2012: http://www.nefsc.noaa.gov/psb/turtles/turtleTracks.html.

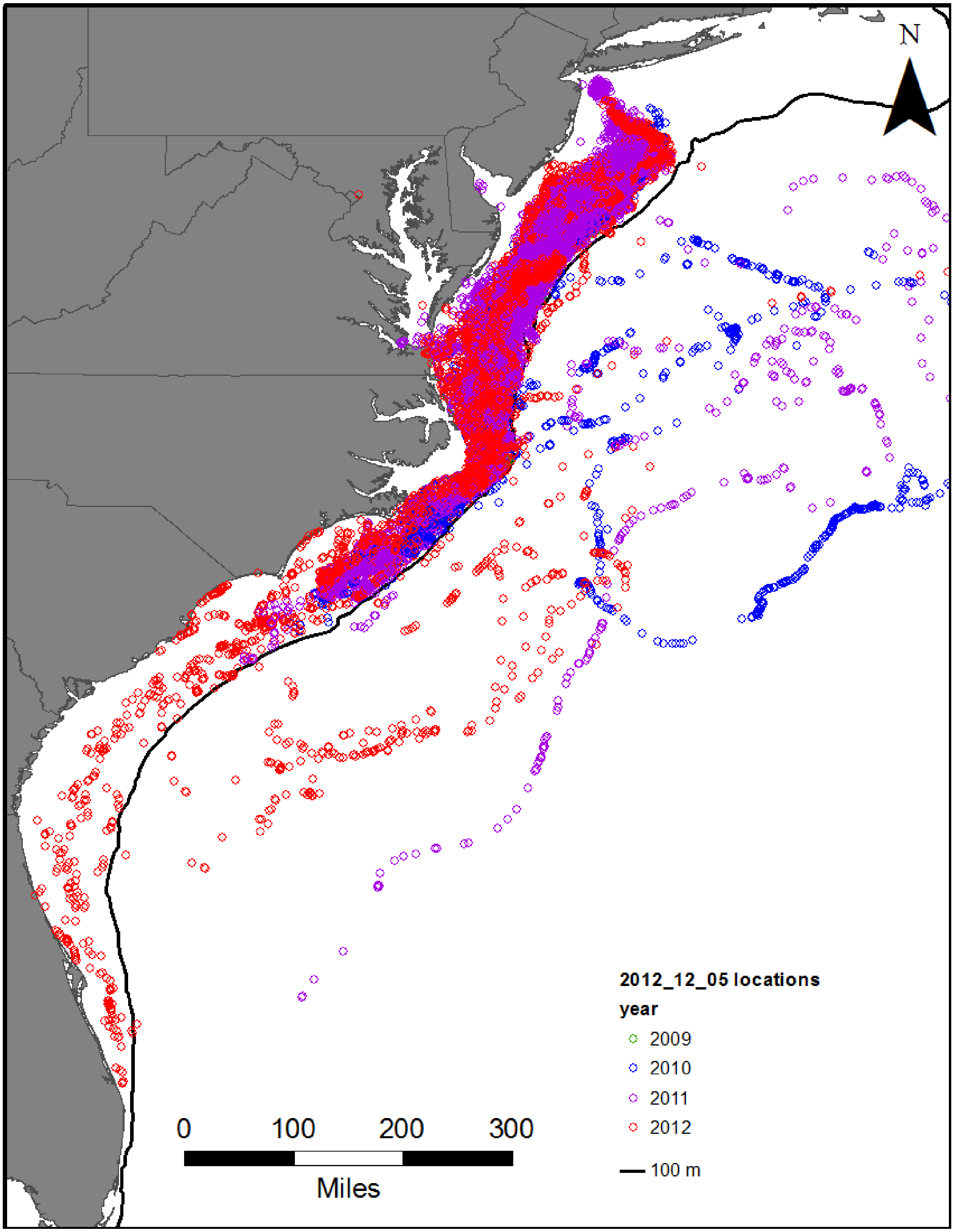
PERMITS

This research was completed under the SEFSC's ESA Permit #1551.

ACKNOWLEDGEMENTS

This research is part of a collaborative effort to learn more about sea turtles in the Northeast region waters. The funds for some of the tags and biological sampling came from Bureau of Ocean Energy Management (BOEM). Staff time was provided by the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Northeast Fisheries Science Center (NEFSC), Northeast Regional Office (NERO), and Coonamessett Farm Foundation (CFF). In particular, we want to thank Lisa Conger, Kat Goetting, Raymond Hines, Eric Matzen, Henry Milliken, and Kate Sampson for their work in the field; Jon O'Neil for his work managing our Oracle database; and Beth Josephson for making the interactive webpage. We owe special thanks to the owners, managers, and crew of the F/Vs Kathy Ann and Ms. Manya. In particular, we'd like to thank James Gutowski, Captain Michael Francis, Captain Peter Dolan, Cory Karch, Paul Solon, Patrick Massimiano, Koji Scott, George West. We also benefited from substantial contributions from Susan Barco, Linda D'Eri and other staff of the Virginia Aquarium & Marine Science Center as well as staff from the Southeast Fisheries Science Center (SEFSC), Robert DiGiovanni of the Riverhead Foundation for Marine Research and Preservation, and Dr. Rogers Williams of the National Marine Life Center.

Figure C1. Locations (class 1, 2, 3) from all 87 tags from AMAPPS and Coonamessett Farm Foundation that were deployed during 2009 – 2012. Since locations are plotted from oldest to newest many older locations are obscured by newer locations.



Appendix C1: SMRU Tag Specifications

Software specification for FA_11A deployment Loggerhead GPS Argos)

Valid for dates in years 2011 to 2014
Transmitting via ARGOS
Page transmission sequences:

Until day 120: 0 1 2 1 3 4 1 2 3 0 1 2 3 0 1 2 3 1 3 1
Until day 200: 0 1 3 1 3 4 1 3 1 3 0 1 3 0 3 1 3 1 3 1
Until day 1464: 0 1 4 1 0 1 1 0 1 1 0 1 4 1 0 1 1 0 1 1
An additional diagnostics page is sent every 60 transmissions

Airtest for first 7 hours:

Transmission interval is chosen randomly between 48 and 72 seconds

Satellite availability (UTC):

00: -- on --
01: -- on --
02: -- on --
03: -- on --
04: -* off *-
05: -- on --
06: -- on --
07: -- on --
08: -- on --
09: -- on --
10: -- on --
11: -- on --
12: -- on --
13: -- on --
14: -- on --
15: -- on --
16: -- on --
17: -- on --
18: -- on --
19: -- on --
20: -- on --
21: -- on --
22: -- on --
23: -- on --

Transmission targets:

50000 transmissions after 200 days
70000 transmissions after 365 days

In Haulouts: ON (one tx every 44 secs) for first 1 day
then cycling OFF for 0, ON for 1 day

Check sensors every 4 secs
When near surface (shallower than 6m), check wet/dry every 1 sec
Consider wet/dry sensor failed if wet for 30 days or dry for 99 days
Dives start when wet and below 1.5m for 20 secs
and end when dry, or above 1.5m
Do not separate 'Deep' dives
No cruises
A haulout begins when dry for 6 mins
and ends when wet for 40 secs

Dive shape (normal dives):
5 points per dive using broken-stick algorithm

Dive shape (deep dives):
none

CTD profiles: max 250 dbar up to 2 dbar in 1 dbar bins.

Temperature: Collected, Stored.
Conductivity: Not collected.
Salinity: Not collected.
Fluorescence: Not collected.
Oxygen: Not collected.
Construct a single profile for each 4-hour period.
During profile, sample CTD sensor every 4 seconds.
Each profile contains 10 cut points
consisting of 0 fixed points, minimum depth, maximum depth, 8 broken-stick points

GPS fixes:
Number of GPS attempts allowed: 5000 (then increase interval to 0x normal)
Cut-off date for GPS attempts: 120 days (then increase interval to 0x normal)
Discard results with fewer than 5 satellites
Processing timeout: 30 secs
Haulouts: Increase interval to 12x normal after first success in haulout

TRANSMISSION BUFFERS (in RAM):
Dives in groups of 2 (5.55556 days @ 10mins/dive): 400 = 1600 bytes
No 'deep' dives
Haulouts: 30 = 120 bytes
6-hour Summaries in groups of 1 (15 days): 60 = 240 bytes
No Timelines
No Cruises

No Diving periods
No Spot depths
No Emergence records
No Dive duration histograms
No Max depth histograms
6-hour Depth & Temperature histograms in groups of 1 (15 days): 60 = 240 bytes
CTD casts (8.33333 days): 50 = 200 bytes
GPS fixes (variable: 63.8889 days if interval is 20 mins): 4600 = 18400 bytes
No Spot CTD's

TOTAL 20800 bytes (of about 21000 available)

MAIN BUFFERS (in 8 or 24 Mb Flash):
Dive in groups of 2 (208.333 days @ 10mins/dive): 15000 x 96 bytes = 1440000 bytes
No 'deep' dives
Haulout: 1000 x 16 bytes = 16000 bytes
6-hour summaries in groups of 1 (500 days): 2000 x 52 bytes = 104000 bytes
6-hour Depth & Temperature histograms in groups of 1 (500 days): 2000 x 24 bytes = 48000 bytes
No timelines
No cruises
No diving periods
No spot depths
No emergence records
No Duration histograms
No Max depth histograms
CTD casts (333.333 days): 2000 x 60 bytes = 120000 bytes
GPS fixes (variable: 70.8333 days if interval is 20 mins): 5100 x 120 bytes = 612000 bytes
No spot CTD's

TOTAL 2285 kb (from 8192 kb available)

PAGE CONTENTS (256 bits - 9 overhead):

PAGE 0:

PTT NUMBER OVERHEAD (28-bit code)
-----------[8 bits: 0 - 7]

PAGE NUMBER
-----------[3 bits: 8 - 10]

DIVE group in format 0:
Normal dives transmitted in groups of 2
Time of start of last dive: max 7 days 12 hours @ 10 secs= 64800
tx as raw 16 bits in units of 1 (range: 0 to 65535)
(recommended sell-by 7 days 11 hours)
Sell-by range: 7 days 6 hours

Number of records: raw 2 bits in units of 1 (range: 0 to 3)
Reason for end: -- not transmitted --
Group number: -- not transmitted --
Max depth: -- not transmitted --
Dive duration: odlog 3/7 in units of 4 s (range: 0 to 130302 s)
Mean speed: -- not transmitted --
Profile data (5 depths/times, 0 speeds):
Depth profile: Lookup with 64 bins: <1,1-2,2-3,3-4,4-5,5-6,6-7,7-8,8-9,9-10,10-11,11-12,12-13,13-14,14-15,15-16,16-17,17-18,18-19,19-20,20-22,22-24,24-26,26-28,28-30,30-32,32-34,34-36,36-38,38-40,40-42,42-44,44-46,46-48,48-50,50-52,52-54,54-56,56-58,58-60,60-62,62-64,64-66,66-68,68-70,70-75,75-80,80-85,85-90,90-95,95-100,100-110,110-120,120-130,130-140,140-150,150-160,160-170,170-180,180-190,190-200,200-220,220-240, >240 in units of 0.1 m (range: 0 to 240 m)
Profile times: raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
Speed profile: -- not transmitted --
Residual: -- not transmitted --
Calculation time: -- not transmitted --
Surface duration: odlog 3/7 in units of 4 s (range: 0 to 130302 s)
Dive area: raw 9 bits in units of 2 permille (range: 0 to 1022 permille)
-----------[236 bits: 11 - 246]

Available bits used exactly
=== End of page 0 ===

PAGE 1:
PTT NUMBER OVERHEAD (28-bit code)
-----------[8 bits: 0 - 7]

PAGE NUMBER
-----------[3 bits: 8 - 10]

SUMMARY group in format 0:
Transmitted in groups of 1
Record could be in buffer for 15 days
End time: max 15 days 6 hours @ 6 hours= 61
tx as raw 6 bits in units of 1 (range: 0 to 63)
(recommended sell-by 14 days 23 hours)
Sell-by range: 15 days
Number of records: raw 1 bits in units of 1 (range: 0 to 1)
Cruising time: -- not transmitted --
Haulout time: raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
Dive time: raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
Deep Dive time: -- not transmitted --
Normal dives:
Avg max dive depth: Lookup with 64 bins: <1,1-2,2-3,3-4,4-5,5-6,6-7,7-8,8-9,9-10,10-11,11-12,12-13,13-14,14-15,15-16,16-17,17-18,18-19,19-20,20-22,22-24,24-26,26-28,28-

30,30-32,32-34,34-36,36-38,38-40,40-42,42-44,44-46,46-48,48-50,50-52,52-54,54-56,56-58,58-60,60-62,62-64,64-66,66-68,68-70,70-75,75-80,80-85,85-90,90-95,95-100,100-110,110-120,120-130,130-140,140-150,150-160,160-170,170-180,180-190,190-200,200-220,220-240, >240 in units of 0.1 m (range: 0 to 240 m)

SD max dive depth: Lookup with 64 bins: <1,1-2,2-3,3-4,4-5,5-6,6-7,7-8,8-9,9-10,10-11,11-12,12-13,13-14,14-15,15-16,16-17,17-18,18-19,19-20,20-22,22-24,24-26,26-28,28-30,30-32,32-34,34-36,36-38,38-40,40-42,42-44,44-46,46-48,48-50,50-52,52-54,54-56,56-58,58-60,60-62,62-64,64-66,66-68,68-70,70-75,75-80,80-85,85-90,90-95,95-100,100-110,110-120,120-130,130-140,140-150,150-160,160-170,170-180,180-190,190-200,200-220,220-240, >240 in units of 0.1 m (range: 0 to 240 m)

Max max dive depth: Lookup with 64 bins: <1,1-2,2-3,3-4,4-5,5-6,6-7,7-8,8-9,9-10,10-11,11-12,12-13,13-14,14-15,15-16,16-17,17-18,18-19,19-20,20-22,22-24,24-26,26-28,28-30,30-32,32-34,34-36,36-38,38-40,40-42,42-44,44-46,46-48,48-50,50-52,52-54,54-56,56-58,58-60,60-62,62-64,64-66,66-68,68-70,70-75,75-80,80-85,85-90,90-95,95-100,100-110,110-120,120-130,130-140,140-150,150-160,160-170,170-180,180-190,190-200,200-220,220-240, >240 in units of 0.1 m (range: 0 to 240 m)

Avg dive duration: odlog 3/7 in units of 4 s (range: 0 to 130302 s)
SD dive duration: odlog 3/7 in units of 4 s (range: 0 to 130302 s)
Max dive duration: odlog 3/7 in units of 4 s (range: 0 to 130302 s)
Avg surface duration: odlog 3/7 in units of 4 s (range: 0 to 130302 s)
SD surface duration: odlog 3/7 in units of 4 s (range: 0 to 130302 s)
Max surface duration: odlog 3/7 in units of 4 s (range: 0 to 130302 s)
Avg speed in dive: -- not transmitted --
Number of dives: odlog 2/4 in units of 1 (range: 0 to 235.5)

Deep dives:

Avg max dive depth: -- not transmitted --
SD max dive depth: -- not transmitted --
Max max dive depth: -- not transmitted --
Avg dive duration: -- not transmitted --
SD dive duration: -- not transmitted --
Max dive duration: -- not transmitted --
Avg surface duration: -- not transmitted --
SD surface duration: -- not transmitted --
Max surface duration: -- not transmitted --
Avg speed in dive: -- not transmitted --
Number of dives: -- not transmitted --

Avg SST: -- not transmitted --
-----------[111 bits: 11 - 121]

DEPTH & TEMPERATURE histogram group in format 0:

Histogram with 5 depth bins:
Transmitted in groups of 1
Record could be in buffer for 15 days
End time: max 15 days 6 hours @ 6 hours= 61
tx as raw 6 bits in units of 1 (range: 0 to 63)
(recommended sell-by 14 days 23 hours)

Sell-by range: 15 days
Number of records: raw 1 bits in units of 1 (range: 0 to 1)
Max. max depth: -- not transmitted --
Dry temperature: -- not transmitted --
Dry usage: raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
Surface temperature: -- not transmitted --
Surface usage (< 1 m): raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
5 depth bins:
Depth band temperature: -- not transmitted --
Usage of depths 1 to 2 m: raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
Usage of depths 2 to 3 m: raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
Usage of depths 3 to 4 m: raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
Usage of depths 4 to 5 m: raw 10 bits in units of 1 permille (range: 0 to 1023 permille)
Usage of depths 5 to 2999 m: raw 10 bits in units of 1 permille (range: 0 to 1023 perm.)
-----------[77 bits: 122 - 198]

HAULOUT in format 0:
Number of records: raw 1 bits in units of 1 (range: 0 to 1)
Haulout number: wraparound 5 bits in units of 1 (range: 0 to 31)
Start time: max 21 days 12 hours @ 2 mins= 15480
tx as raw 14 bits in units of 1 (range: 0 to 16383)
(recommended sell-by 21 days 11 hours)
End time: max 21 days 12 hours @ 2 mins= 15480
tx as raw 14 bits in units of 1 (range: 0 to 16383)
(recommended sell-by 21 days 11 hours)
Sell-by range: 21 days
Duration: -- not transmitted --
cf. Max duration is 1 day
Reason for end: -- not transmitted --
Contiguous: -- not transmitted --
-----------[34 bits: 199 - 232]

DIAGNOSTICS in format 0:

TX number: wraparound 14 bits in units of 5 (range: 0 to 81915)
-----------[14 bits: 233 - 246]

Available bits used exactly
=== End of page 1 ===

PAGE 2:
PTT NUMBER OVERHEAD (28-bit code)
-----------[8 bits: 0 - 7]

PAGE NUMBER
-----------[3 bits: 8 - 10]

GPS in format 1:

Timestamp: max 3 days @ 1 sec= 259200
tx as raw 18 bits in units of 1 (range: 0 to 262143)
(recommended sell-by 2 days 23 hours)
Sell-by range: 2 days 21 hours
n_sats: raw 3 bits in units of 1 (range: 5 to 12)
GPS mode: -- not transmitted --
Best 8 satellites:
Sat ID's: raw 5 bits in units of 1 (range: 0 to 31)
Pseudorange: raw 15 bits in units of 1 (range: 0 to 32767)
Signal strength: -- not transmitted --
Doppler: -- not transmitted --
Max signal strength: -- not transmitted --
Noisefloor: -- not transmitted --
Max CSN (x10): raw 5 bits in units of 5 (range: 320 to 475)
-----------[186 bits: 11 - 196]

DIAGNOSTICS in format 1:

Wettest (min wet/dry): raw 7 bits in units of 2 (range: 0 to 254)
Driest (max wet/dry): raw 8 bits in units of 1 (range: 0 to 255)
GPS zero satellites: wraparound 11 bits in units of 1 (range: 0 to 2047)
GPS 1-4 satellites: wraparound 10 bits in units of 1 (range: 0 to 1023)
GPS 5 or more satellites: wraparound 12 bits in units of 1 (range: 0 to 4095)
GPS reboots: wraparound 2 bits in units of 1 (range: 0 to 3)
-----------[50 bits: 197 - 246]

Available bits used exactly
=== End of page 2 ===

PAGE 3:
PTT NUMBER OVERHEAD (28-bit code)
-----------[8 bits: 0 - 7]

PAGE NUMBER
-----------[3 bits: 8 - 10]

GPS in format 0:

Timestamp: max 192 days @ 1 sec= 16588800
tx as raw 24 bits in units of 1 (range: 0 to 1.67772e+07)
(recommended sell-by 191 days 23 hours)
Sell-by range: 190 days
n_sats: raw 3 bits in units of 1 (range: 5 to 12)

GPS mode: -- not transmitted --
Best 8 satellites:
Sat ID's: raw 5 bits in units of 1 (range: 0 to 31)
Pseudorange: raw 15 bits in units of 1 (range: 0 to 32767)
Signal strength: -- not transmitted --
Doppler: -- not transmitted --
Max signal strength: -- not transmitted --
Noisefloor: -- not transmitted --
Max CSN (x10): raw 5 bits in units of 5 (range: 320 to 475)
-----------[192 bits: 11 - 202]

DIAGNOSTICS in format 2:

Tag time (mm:ss): raw 11 bits in units of 2 secs (range: 0 to 4094 secs)
GPS zero satellites: wraparound 11 bits in units of 1 (range: 0 to 2047)
GPS 1-4 satellites: wraparound 10 bits in units of 1 (range: 0 to 1023)
GPS 5 or more satellites: wraparound 12 bits in units of 1 (range: 0 to 4095)
-----------[44 bits: 203 - 246]

Available bits used exactly
=== End of page 3 ===

PAGE 4:
PTT NUMBER OVERHEAD (28-bit code)
-----------[8 bits: 0 - 7]

PAGE NUMBER
-----------[3 bits: 8 - 10]

CTD PROFILE in format 0:

End time: max 7 days 12 hours @ 4 hours= 45
tx as raw 6 bits in units of 1 (range: 0 to 63)
(recommended sell-by 7 days 7 hours)
Sell-by range: 7 days
CTD cast number: -- not transmitted --
Min pressure: -- not transmitted --
Max pressure: raw 8 bits in units of 1 dbar (range: 2 to 257 dbar)
Min temperature: raw 12 bits in units of 0.01 (range: 0 to 40.95 = -5 to 35.95 °C in steps of 0.01 °C)
Max temperature: raw 12 bits in units of 0.01 (range: 0 to 40.95 = -5 to 35.95 °C in steps of 0.01 °C)
Number of samples: -- not transmitted --
10 profile points 0 to 9 (from total of 10 cut points):
Temperature:
Min pressure is sent separately

Max pressure is sent separately
8 broken stick pressure bins: raw 8 bits in units of 1 bin (range: 0 to 255 bin)
10 x Temperature: raw 8 bits in units of 3.92157 permille (range: 0 to 1000 permille)
Temperature residual: -- not transmitted --
Temperature bounds : -- not transmitted --
Conductivity bounds : -- not transmitted --
Salinity bounds : -- not transmitted --
Min fluoro: -- not transmitted --
Max fluoro: -- not transmitted --
Min oxy: -- not transmitted --
Max oxy: -- not transmitted --
-----------[182 bits: 11 - 192]

HAULOUT in format 0:
Number of records: raw 1 bits in units of 1 (range: 0 to 1)
Haulout number: wraparound 5 bits in units of 1 (range: 0 to 31)
Start time: max 21 days 12 hours @ 2 mins= 15480
tx as raw 14 bits in units of 1 (range: 0 to 16383)
(recommended sell-by 21 days 11 hours)
End time: max 21 days 12 hours @ 2 mins= 15480
tx as raw 14 bits in units of 1 (range: 0 to 16383)
(recommended sell-by 21 days 11 hours)
Sell-by range: 21 days
Duration: -- not transmitted --
cf. Max duration is 1 day
Reason for end: -- not transmitted --
Contiguous: -- not transmitted --
-----------[34 bits: 193 - 226]

DIAGNOSTICS in format 3:

ADC offset: raw 6 bits in units of 25 A/D units (range: 0 to 1575 A/D units)
Max depth ever: raw 6 bits in units of 5 m (range: 0 to 315 m)
Driest (max wet/dry): raw 8 bits in units of 1 (range: 0 to 255)
-----------[20 bits: 227 - 246]

Available bits used exactly
=== End of page 4 ===

PAGE 5 (special diagnostics page sent every 60 transmissions)
PTT NUMBER OVERHEAD (28-bit code)
-----------[8 bits: 0 - 7]

PAGE NUMBER
-----------[3 bits: 8 - 10]

TX number: wraparound 18 bits in units of 1 (range: 0 to 262143)
Current state: raw 3 bits in units of 1 (range: 0 to 7)
Tag time (mm:ss): raw 12 bits in units of 1 secs (range: 0 to 4095 secs)
ADC offset: raw 12 bits in units of 1 A/D units (range: 0 to 4095 A/D units)
Tag hours: wraparound 16 bits in units of 1 hours (range: 0 to 65535 hours)
Wet/dry status: raw 2 bits in units of 1 (range: 0 to 3)
Wet/dry fail count: wraparound 8 bits in units of 1 (range: 0 to 255)
Body number: raw 16 bits in units of 1 (range: 0 to 65535)
Max depth ever: raw 15 bits in units of 0.1 m (range: 0 to 3276.7 m)
Latest reset hour: raw 16 bits in units of 1 hours (range: 0 to 65535 hours)
Number of resets: wraparound 8 bits in units of 1 (range: 0 to 255)
Wettest (min wet/dry): raw 8 bits in units of 1 (range: 0 to 255)
Driest (max wet/dry): raw 8 bits in units of 1 (range: 0 to 255)
GPS zero satellites: wraparound 14 bits in units of 1 (range: 0 to 16383)
GPS 1-4 satellites: wraparound 14 bits in units of 1 (range: 0 to 16383)
GPS 5 or more satellites: wraparound 14 bits in units of 1 (range: 0 to 16383)
GPS reboots: wraparound 4 bits in units of 1 (range: 0 to 15)
Current temperature: raw 16 bits in units of 0.001 (range: 0 to 65.535 = -5 to 60.535 °C in steps of 0.001 °C)
Number of depth spikes: wraparound 8 bits in units of 1 (range: 0 to 255)
Number of CTD samples: wraparound 22 bits in units of 1 (range: 0 to 4.1943e+06)
-----------[234 bits: 11 - 244]

UNUSED
-----------[2 bits: 245 - 246]

=== End of page 5 ===

Appendix D: *Harbor seal abundance survey: Northeast Fisheries Science Center*

Gordon T. Waring[1], James R. Gilbert[2], Robert A. DiGiovanni Jr[3]

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SUMMARY

As part of the AMMAPS program, a multi-agency team first conducted harbor seal (*Phoca vitulina concolor*) live capture, tagging, and biological sampling in waters off of Cape Cod, MA and western Penobscot Bay, ME and then, during the peak pupping period, conducted aerial surveys along the Maine coast. This project was scheduled for completion in 2011, but as noted in the 2011 annual AMMAPS report, the aerial survey component was not completed due to poor weather. In late-March 2012, 22 harbor seals were captured in Chatham Harbor, MA. In mid-April, 15 additional harbor seals were captured in western Penobscot Bay, ME. However, 5 Chatham and 3 Maine seals escaped unharmed during disentanglement from the capture net. All remaining Chatham and Maine seals were radio and flipper tagged, and tissue samples were collected. The aerial survey (NOAA Twin Otter) and radio tracking (USFWS Kodiak) components were conducted from 27 May – 2 June 2012 along the coast of Maine, from Cape Elizabeth to eastern Machias Bay. Of the 15 bay "sampling" units, 13 were surveyed. Due to weather conditions the remaining two could not be completed. Radio tagged seals were detected on all days, where both the daily total number and number of unique tags were highly variable. Counting of all images is expected to be completed by the end of January 2013. Statistical analyses and abundance estimation is scheduled to be completed in February 2013 and reported in the next marine mammal stock assessment report which will be reviewed at the March 2013 Atlantic Scientific Review Group Meeting.

OBJECTIVES

The goals of this project were to:

1) Develop a statistically robust harbor seal aerial abundance survey design based on bay units that were delineated in a 2001 abundance survey (Gilbert et al. 2005);
2) Conduct harbor seal live capture and VHF tagging in Chatham Harbor, MA, and western Penobscot Bay, ME;
3) Conduct aerial photographic surveys and VHF radio tracking along the Maine coast during peak pupping period; and
4) Write a report suitable for publication in a peer review journal.

METHODS

Survey design

The survey design was intended to estimate the number of harbor seals in Maine with a minimum variance. The design was to take into consideration the following: resources for capturing a sufficient number of individuals to develop a haul-out behavior model is not feasible; aircrafts for multiple replicate counts are not available; and the time window for counts during the pupping season (i.e., late May to early June) is no more than eight days which is one tidal cycle with low tides between 0900 and 1800. The design also needed to minimize aircraft time for safety considerations; the less time spent "on the wing", the less risk to the pilots and observers. In addition, the design assumed that photographic seal counts on haul-out sites were collected at 750 ft altitude by circling and photographing ledges and islands with seals.

Capture, sampling and tagging
Harbor seal capture operations followed protocols used in prior NEFSC efforts (Gilbert et al. 2005; Waring et al. 2006), which are similar to procedures followed in other regions (Jeffries et al. 1993; Withrow and Loughlin 1997). Seals were captured by setting a nylon twine research gillnet (100 x 7.4 m) off specific haul-out locations (i.e., sand bars and beaches in Chatham Harbor, MA, or tidal ledges in western Penobscot Bay, ME) during low tide periods (Figure D1). Seals typically flee into the water at the approach of the set boat, and the goal was to entangle some seals in the net. Once entangled, researchers in assisting boats brought the seals aboard their boats and guided them into hoop nets. Once all seals were secured in hoop nets, they were moved to the designated handling site (e.g., beach or boat). The full sampling and tagging protocol included: external examination, weight, morphometrics, sex, age class, ultrasound, blood draw, flipper tagging (flipper punch tissue is the genetic sample), and attaching VHF coded transmitters (Lotek model RMMT-4). However, the complete sampling protocol was not conducted for each animal due to logistics and animal activity level. Satellite tags and acoustic tags were not available for the 2012 work. VHF tags were attached to the pelage using 5-minute epoxy (Fedak et al. 1983). Numbered and labeled flipper tags (Destron Fearing Sheep and Goat) were attached to one hind flipper of each seal.

Aerial survey and radio tracking
The usual protocol for conducting a simultaneous harbor seal photographic survey and radio tracking operation involves two independent aircraft and survey teams (Gilbert et al. 2005; Huber et al. 2001; Jeffries et al. 2003; Ries et al. 1998). For the 2012 survey, a NOAA Twin Otter was the photographic aircraft and a USFWS Kodiak was the radio tracking platform. The Kodiak was equipped with wing mounted omni directional antennas and they were cabled to a Lotek Receiver (Model SRX400) to locate the VHF tag seals. In addition, a single omni-directional antenna was mounted in the belly port of the Otter, and connected to another Lotek Receiver. Aerial operations for both aircraft were conducted two hours around low tide (about 4 hrs total), excluding transit times from/to airport. The USFWS Kodiak searched for radio tagged seals in Maine by flying a loop, altitude of 204 m (1,000 ft), extending from Cape Elizabeth to Mount Desert Island (Figure E2). The Twin Otter surveyed Maine seal haulout ledges at an altitude of about 230 m (750 ft), and oblique photographs were taken from a left side rear pop-out window using a Canon 7D with a 1.4x extender and 300mm stabilized lens.

RESULTS
Scientists from 14 difference organizations participated in this project (Table D1).

Survey design
The survey design that was developed resulted in a harbor seal abundance estimate which was based on sample counts of segments of the coast (bay units) corrected for the fractions of seals not available to be counted within each bay unit. This involved first, before the pupping season, capturing and tagging a sample of the seal population. Then during the pupping season, photographing a sample of the haul-out sites and simultaneous determining which of the tagged

seals were on haul-out sites. A summary of the design has been provided below and the full description is in Appendix D1 of the 2011 Annual AMAPPS report (http://www.nefsc.noaa.gov/read/protspp/mainpage/AMAPPS/). The survey design was reviewed by NMFS pinniped researchers at the National Marine Mammal Laboratory, Seattle, WA.

Capture, sampling and tagging
Harbor seal capture operations were conducted in Chatham Harbor, on Cape Cod, MA during 24 – 30 March 2012 (Figure D1; Table D2). Twenty-two harbor seals were captured, but five escaped during retrieval from the net. Seventeen harbor seals (9 males and 8 females) were flipper and radio tagged, and biological samples were collected (Tables D3 – D4).

Capture work in western Penobscot Bay, ME was conducted during 12 – 17 April 2012 (Figure D1; Table D2). Fifteen harbor seals were captured. Three seals escaped during retrieval from the capture net. Twelve seals (6 males and 6 females) were flipper and radio tagged, and biological samples were collected (Tables D3 – D4).

Aerial survey and radio tracking
Aerial survey and radio tracking flights were conducted during 27 May – 2 June 2012. Weather precluded operations on 29 May, thus only thirteen of the fifteen bay units were surveyed (Table D5). Four to eight tags were detected each day, overall 18/29 (62%) of the tagged animals were detected at least once (Table D6).

Data analysis
Counting and data entry of digital images for 11 of the 13 bay units were completed by the end of December 2012. Counting of the remaining two units will be completed by late January 2013. Second counts of haul-out sites (n = 32) where 20 or more images were taken will also be completed by mid February. The objective of the second counts is to ensure that seals on overlapping images were not double counted and to review images where designations of pups versus non-pups, or gray seals versus harbor seals were difficult.

Statistical analysis to obtain a current estimate of harbor seal abundance (pups and non-pups) will commence at the completion of the counting. The target completion date for the harbor seal abundance estimate is mid-February 2013. These results will then be reported in the next Stock Assessment Report (SAR) and will result in a paper documenting the methods and results.

DISPOSITION OF DATA
All data collected during this project will be maintained by the Protected Species Branch at NEFSC in Woods Hole, MA. The computerized data from the tags, photographs and samples are archived in the NEFSC Oracle database. The collected biological samples were sent to several organizations that are analyzing the samples, including Woods Hole Oceanographic Institution and Cornell University.

PERMITS
NEFSC was authorized to conduct seal research activities during the study under Permit No. 775-1875 issued to the NEFSC by the NMFS Office of Protected Resources. NEFSC was also

issued a National Park Service (NPS) Special Use Permit #CACO-2011-SCI-0003 to conduct the research activities on Cape Cod National Seashore Property (i.e., the capture and tagging work).

ACKNOWLEDGEMENTS

The funds for this project came from the Bureau of Ocean Energy Management (BOEM) and the US Navy through two Interagency Agreements for the AMAPPS project. We would also like to thank the NMFS National Marine Mammal Health and Stranding Response Program for providing biological sampling supplies. We are grateful to the Maine Marine Patrol for use of their dock facilities in Rockland, Maine.

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Table D1. Participants in the 2012 harbor seal live capture, sampling, tagging and abundance project.

Name	Affiliation
Andrea Bogomolni[1]	University of Connecticut & Woods Hole Oceanographic Institution
Allison Chaillet[1]	Riverhead Foundation for Marine Research and Preservation
Robert DiGiovanni[1,2]	Riverhead Foundation for Marine Research and Preservation
Lynda Doughty[1]	Marine Mammals of Maine
Peter Duley[2]	NOAA/NMFS/Northeast Fisheries Science Center
Kim Durham[1]	Riverhead Foundation for Marine Research and Preservation
Mendy Garron[1]	NOAA/NMFS Northeast Regional Office
Jen Gatzke[2]	Integrated Statistics Inc, Woods Hole, MA
James R. Gilbert[1,2]	University of Maine, Dept. Wildlife Ecology
Bill Greer[1]	Integrated Statistics Inc, Woods Hole, MA
Lanni Hall[1]	NOAA/NMFS Northeast Regional Office
Mike Hammill[1]	Department of Fisheries and Oceans, IML Mont-Joli, Quebec
John Jensen[1]	NOAA/NMFS National Marine Mammal Laboratory Seattle, WA
Beth Josephson[1]	Integrated Statistics Inc, Woods Hole, MA
Christin Khan[1]	NOAA/NMFS/Northeast Fisheries Science Center
Keith Matassa1	University of New England
Betty Lentell[1]	Woods Hole Oceanographic Institution, Biology Dept.
Liz Ouellette[1]	Integrated Statistics Inc, Woods Hole, MA
Richard Pace[1]	NOAA/NMFS/Northeast Fisheries Science Center
Belinda Rubinstein[1]	Bridgewater State University
Lisa Sette[1]	Provincetown Center for Coastal Studies
Mike Simpkins[1]	NOAA/NMFS/Northeast Fisheries Science Center
Gordon T. Waring[1,2]	NOAA/NMFS/Northeast Fisheries Science Center
Fred Wenze1[1]	NOAA/NMFS/Northeast Fisheries Science Center
Stephanie Wood[1,2]	Integrated Statistics Inc, Woods Hole, MA
Yong-Rock An[1]	Visiting Scientist at NEFSC, National Fisheries Research & Development Institute Ulsan, Republic of Korea

[1] Live capture, sampling, tagging participants
[2] Abundance survey & image counting participants

Table D2. Harbor seal live capture attempt events log for 2012 field season.

Date (mmddyyyy)	Time	Location	Lat: (dd/mm)	Long: (dd/mm)	Set #	Seals 0=No 1=Yes	# other species	# Pv Taken	# Caught	# Escap	# Sampled	SI/Mort. 0=No 1=Yes
03/24/12	9:24	Chatham Hbr., MA	41.41	69.56	1	1	0	150	9	2	7	0
03/28/12	10:00	Chatham Hbr., MA	41.41	69.57	1	1	0	120	0	0	0	0
03/28/12	10:44	Chatham Hbr., MA	41.41	69.56	2	1	0	80	1	1	0	0
03/28/12	11:49	Chatham Hbr., MA	41.41	69.56	3	1	0	6	0	0	0	0
03/28/12	12:19	Chatham Hbr., MA	41.41	69.56	4	1	0	5	0	0	0	0
03/29/12	9:53	Chatham Hbr., MA	41.41	69.57	1	1	0	120	0	0	0	0
03/29/12	11:16	Chatham Hbr., MA	41.41	69.56	2	1	0	100	7	0	7	0
03/30/12	12:49	Chatham Hbr., MA	41.41	69.56	1	1	0	120	5	2	3	0
04/12/12	10:16	Mouse Island, ME	44.12	68.58	1	1	0	30	0	0	0	0
04/12/12	11:36	South of Mouse Is., ME	44.10	68.57	2	1	0	20	0	0	0	0
04/12/12	12:12	Ledges north of Mark Is., ME	44.10	68.56	3	1	0	10	0	0	0	0
04/12/12	12:52	East Goose Rock, ME	44.10	68.58	4	1	0	15	0	0	0	0
04/13/12	9:20	Ledges north of Camp Is., ME	44.00	69.02	1	1	1	18	6	1	4	0
04/13/12	12:39	Ledges off Little Pond, ME	44.00	69.03	2	1	0	40	0	0	0	0
04/13/12	13:22	Dix Harbor, ME	44.00	69.04	3	1	0	40	2	1	1	0
04/14/12	9:50	Ledges off Camp Is., ME	44.00	69.02	1	1	0	12	0	0	0	0
04/14/12	10:20	Spectacle Is., ME	44.01	69.03	2	1	0	30	2	1	1	0
04/14/12	11:30	Ledges near Spectacle Is., ME	44.00	69.03	3	1	0	60	0	0	0	0
04/14/12	13:05	Plesant Is., ME	43.58	69.04	4	1	1-5 Hg	40	0	0	0	0
04/14/12	14:17	Dix Is., ME	44.00	69.04	5	1	0	30	2	0	2	0
04/15/12	10:15	Mouse Is., ME	44.12	68.56	1	1	0	15	0	0	0	0
04/15/12	11:21	Mark Is., ME	44.10	68.58	2	1	0	30	1	0	1	0
04/15/12	12:50	Ledges around Robinson Rock, ME	44.09	68.58	3	1	0	10	0	0	0	0
04/15/12	13:28	South side Robinson Rock, ME	44.09	68.58	4	1	0	2	0	0	0	0
04/15/12	13:59	Goose Is., ME	44.11	68.51	5	1	0	15	0	0	0	0

Table D2 cont. Harbor seal live capture attempt events log for 2012 field season.

Date (mmddyyyy)	Time	Location	Lat: (dd/mm)	Long: (dd/mm)	Set #	Seals 0=No 1=Yes	# other species	# Pv Taken	# Caught	# Escap	# Sampled	SI/Mort. 0=No 1=Yes
04/16/12	11:13	Dix Is., ME	44.00	69.04	1	1	0	15	0	0	0	0
04/16/12	11:35	No Name ledges, ME	43.59	69.04	2	1	0	0	0	0	0	0
04/16/12	12:30	No Name ledges, ME	43.59	69.03	3	1	0	50	0	0	0	0
04/16/12	13:00	No Name ledges, ME	44.00	69.02	4	1	0	9	0	0	0	0
04/16/12	13:49	No Name ledges, ME	44.00	69.02	5	1	0	20	0	0	0	0
04/16/12	14:18	Great Pond, ME	44.00	69.03	6	1	0	60	0	0	1	0
04/16/12	14:20	Spectacle Is., ME	44.01	69.03	7	1	0	8	0	0	0	0
04/16/12	16:08	Nettle Island, ME	43.59	69.04	8	1	0	15	0	0	0	0
04/17/12	14:10	Near Gooseberry Is., ME	44.01	69.03	1	1	0	30	0	0	0	0
04/17/12	15:09	No Name ledges, ME	44.00	69.02	2	1	0	50	2	0	2	0
04/17/12					3	1	0		0	0	0	0
04/17/12					4	1	0		0	0	0	0
04/17/12	17:24	Near Dix Is., ME	44.00	69.04	5	1	0	12	0	0	0	0
04/17/12	18:00	Near Dix Is., ME	44.00	69.04	6	1	0	8	0	0	0	0
Totals						**39**	**6**	**1395**	**37**	**8**	**29**	**0**

Pv = *Phoca vitulina* = harbor seal
Hg = *Halichoerus grypus* = gray seal
SI/Mort = serious injury or mortality

Table D3. Harbor seal tagging conducted during March & April 2012 live capture project.

Location	Date	Flip per tag #	Flipper tag color	Radio tag freq.	Code	Sex	Conditi on	Released 1=Yes / 0=No
Chatham Harbor	3/24/2012	28	Orange	151.540	8	F	Alive	1
Chatham Harbor	3/24/2012	25	Orange	151.280	17	M	Alive	1
Chatham Harbor	3/24/2012	24	Orange	151.280	13	M	Alive	1
Chatham Harbor	3/24/2012	23	Orange	151.280	5	M	Alive	1
Chatham Harbor	3/24/2012	20	Orange	151.280	15	M	Alive	1
Chatham Harbor	3/24/2012	29	Orange	151.320	7	M	Alive	1
Chatham Harbor	3/24/2012	32	Orange	151.320	9	M	Alive	1
Chatham Harbor	3/29/2012	35	Orange	151.320	1	F	Alive	1
Chatham Harbor	3/29/2012	26	Orange	151.280	19	M	Alive	1
Chatham Harbor	3/29/2012	27	Orange	151.540	4	F	Alive	1
Chatham Harbor	3/29/2012	30	Orange	151.320	2	F	Alive	1
Chatham Harbor	3/29/2012	31	Orange	151.540	19	M	Alive	1
Chatham Harbor	3/29/2012	33	Orange	151.540	19	F	Alive	1
Chatham Harbor	3/29/2012	34	Orange	151.540	3	F	Alive	1
Chatham Harbor	3/30/2012	37	Orange	151.320	10	F	Alive	1
Chatham Harbor	3/30/2012	36	Orange	151.320	8	M	Alive	1
Chatham Harbor	3/30/2012	38	Orange	151.320	4	F	Alive	1
Ledges north of Camp Is., ME	4/13/2012	39	Orange	151.540	13	M	Alive	1
Ledges north of Camp Is., ME	4/13/2012	40	Orange	151.320	6	M	Alive	1
Ledges north of Camp Is., ME	4/13/2012	41	Orange	150.700	3	F	Alive	1
Ledges north of Camp Is., ME	4/13/2012	42	Orange	151.540	17	M	Alive	1
Dix Harbor, ME	4/13/2012	43	Orange	151.540	11	M	Alive	1
Spectacle Is., ME	4/14/2012	44	Orange	151.540	7	F	Alive	1
Dix Is., ME	4/14/2012	45	Orange	151.540	10	F	Alive	1
Dix Is., ME	4/14/2012	46	Orange	151.540	18	F	Alive	1
Mark Is., ME	4/15/2012	47	Orange	151.540	1	M	Alive	1
Great Pond Is., ME	4/16/2012	48	Orange	151.540	5	M	Alive	1
Ledges north of Camp Is., ME	4/17/2012	49	Orange	151.540	2	F	Alive	1
Ledges north of Camp Is., ME	4/17/2012	50	Orange	151.280	18	F	Alive	1
Totals					**M**	**15**		**29**
					F	**14**		
					Total	**29**		

Table D4. Harbor biological sampling conducted during March and April 2012 live capture project.

Location	Date	Flipper tag #	Released 1=Yes/ 0=No	Genetic frozen	DMSO frozen	Culture nasal	Anal nasal	Hair	Tiger top	Lavender	Green	Scat
Chatham Harbor	3/24/2012	28	1	1	1	2	0	1	1	1	1	0
Chatham Harbor	3/24/2012	25	1	1	0	2	2	1	1	1	1	0
Chatham Harbor	3/24/2012	24	1	1	1	2	0	1	2	2	2	0
Chatham Harbor	3/24/2012	23	1	1	1	2	0	0	0	0	0	0
Chatham Harbor	3/24/2012	20	1	1	0	2	0	0	1	0	1	0
Chatham Harbor	3/24/2012	29	1	1	1	2	0	0	2	2	2	0
Chatham Harbor	3/24/2012	32	1	1	0	0	0	1	0	0	0	0
Chatham Harbor	3/29/2012	35	1	1	1	2	3	1	2	2	2	0
Chatham Harbor	3/29/2012	26	1	1	1	2	3	1	1	2	2	0
Chatham Harbor	3/29/2012	27	1	1	1	2	2	0	1	0	0	0
Chatham Harbor	3/29/2012	30	1	1	1	2	3	1	2	2	2	0
Chatham Harbor	3/29/2012	31	1	1	1	2	0	0	0	0	0	0
Chatham Harbor	3/29/2012	33	1	1	1	2	3	1	1	2	2	0
Chatham Harbor	3/29/2012	34	1	1	1	2	3	1	0	0	0	0
Chatham Harbor	3/30/2012	37	1	1	1	2	2	1	1	0	0	0
Chatham Harbor	3/30/2012	36	1	1	1	2	2	1	0	0	0	0
Chatham Harbor	3/30/2012	38	1	1	0	2	3	1	3	1	2	0

Table D4 cont. Harbor biological sampling conducted during March and April 2012 live capture project.

Location	Date	Flipper tag #	Released 1=Yes/ 0=No	Genetics frozen	DMSO frozen	Culture nasal	Anal nasal	Hair	Tiger top	Lavender	Green	Scat
Ledges north of Camp Is., ME	4/13/2012	39	1	1	0	2	3	1	3	2	2	0
Ledges north of Camp Is., ME	4/13/2012	40	1	1	1	2	2	1	1	2	2	0
Ledges north of Camp Is., ME	4/13/2012	41	1	1	1	2	3	1	2	1	1	0
Ledges north of Camp Is., ME	4/13/2012	42	1	1	1	2	3	1	1	2	4	0
Dix Harbor, ME	4/13/2012	43	1	?	?	2	0	1	3	2	2	0
Spectacle Is., ME	4/14/2012	44	1	1	0	2	3	1	2	0	0	0
Dix Is., ME	4/14/2012	45	1	1	1	2	1	1	2	0	1	0
Dix Is., ME	4/14/2012	46	1	1	0	2	3	1	2	0	1	0
Mark Is., ME	4/15/2012	47	1	1	1	2	2	1	2	0	1	0
Great Pond Is., ME	4/16/2012	48	1	1	1	2	3	1	1	0	0	1
Ledges north of Camp Is., ME	4/17/2012	49	1	1	1	2	3	1	2	1	4	0
Ledges north of Camp Is., ME	4/17/2012	50	1	1	1	2	3	1	2	1	2.5	0
	Total		**29**	**28**	**21**	**56**	**55**	**24**	**41**	**26**	**37.5**	**1**

Table D5. Aerial survey sampling units

Bay unit	Name	Days to survey	Dates surveyed
BHBIH	Blue Hill Bay - Isle Au Haut	1	1-Jun
BHBSI	Blue Hill Bay - Swans Island	1	1-Jun
BHBUP	Blue Hill Bay - Upper	1	30-May
CASB	Casco Bay	1	28-May
EB	Eastern Bay	1	27-May
FB & MDI	Frenchman Bay & Mt. Desert Is.	1	27-May
MACHB	Machias Bay	1	27-May
MUSCB	Muscongus Bay	1	28-May
PBMC	Penobscot Bay - Muscle Channel	1	2-Jun
PBMW	Penobscot Bay - Midwest	1	27-May
BHBMR	Blue Hill Bay Merchants Row	2	31-May; 1-Jun
PBEA	Penobscot Bay - Eastern	2	1-Jun; 2-Jun
PBVL	Penobscot Bay Vinalhaven	2	31 May; 1- Jun
PNDB	Pleasant, Narguagus & Denny Bays	survey not completed	
WB	Western Bay		

Table D6. Radio tag detections by the Kodiak and Twin Otter during the 2012 harbor seal abundance survey.

Tag and Seal Information					Kodiak							Twin Otter							Totals	
Radio tag Freq.	Code	Flipper tag	Sex	Deployment Location	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	Total Detections	Unique Tags detected
150.700	3	41	F	Rockland	1														1	1
151.280	5	23	M	Chatham											1	1			2	1
151.280	13	24	M	Chatham	1			1		1							1		4	1
151.280	15	20	M	Chatham	1														1	1
151.280	17	25	M	Chatham	1	1			1	1			1					1	6	1
151.280	18	50	F	Rockland				1			1					1		1	4	1
151.280	19	26	M	Chatham															0	0
151.540	1	47	M	Rockland	1					1									2	1
151.540	2	49	F	Rockland	1			1		1	1							1	5	1
151.540	3	34	F	Chatham															0	0
151.540	4	27	F	Chatham						1						1			2	1
151.540	5	48	M	Rockland				1	1	1	1					1		1	6	1
151.540	7	44	F	Rockland													1		1	1
151.540	8	28	F	Chatham															0	0
151.540	10	45	F	Rockland		1		1	1	1	1							1	6	1
151.540	11	43	M	Rockland															0	0
151.540	13	39	M	Rockland															0	0
151.540	14	33	F	Chatham															0	0
151.540	17	42	M	Rockland															0	0
151.540	18	46	F	Rockland						1	1								2	1
151.540	19	31	M	Chatham															0	0
151.320	1	35	F	Chatham	1														1	1
151.320	2	30	F	Chatham	1	1			1				1						4	1
151.320	4	38	F	Chatham															0	0
151.320	6	40	M	Rockland				1	1		1					1			4	1
151.320	7	29	M	Chatham															0	0
151.320	8	36	M	Chatham													1		1	1

Table D6 cont. Radio tag detections by the Kodiak and Twin Otter during the 2012 harbor seal abundance survey

Tag and Seal Information					Kodiak							Twin Otter							Totals	
Radio tag Freq.	Code	Flipper tag	Sex	Deployment Location	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	Total Detections	Unique Tags detected
151.320	9	32	M	Chatham															0	0
151.320	10	37	F	Chatham		1							1						2	1
Total Detections					**8**	**4**	**0**	**6**	**5**	**8**	**6**	**0**	**3**	**0**	**1**	**5**	**3**	**5**	**54**	**18**

Figure D1. Harbor seal capture/tagging locations and example aerial survey track lines from spring 2012 study.

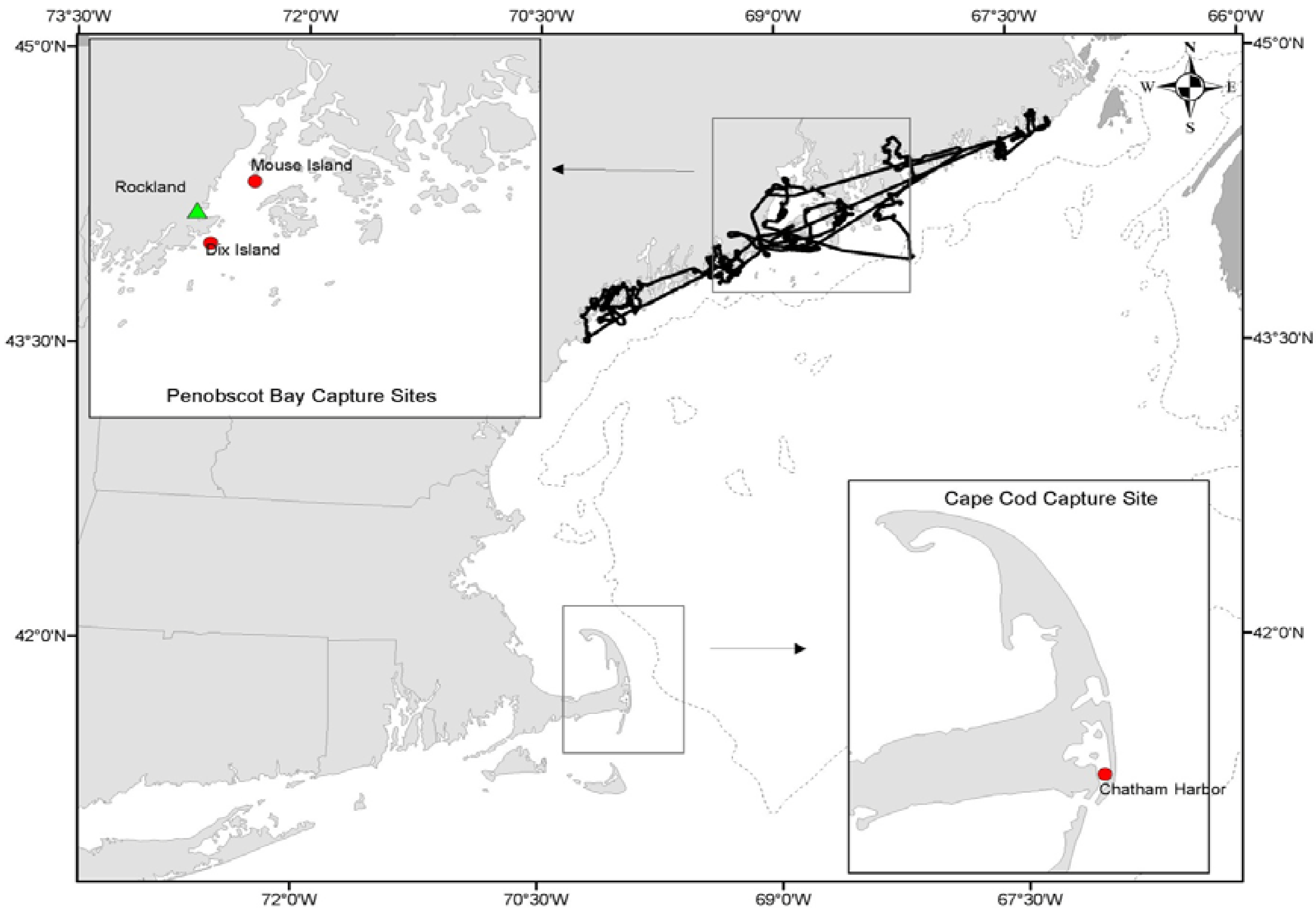
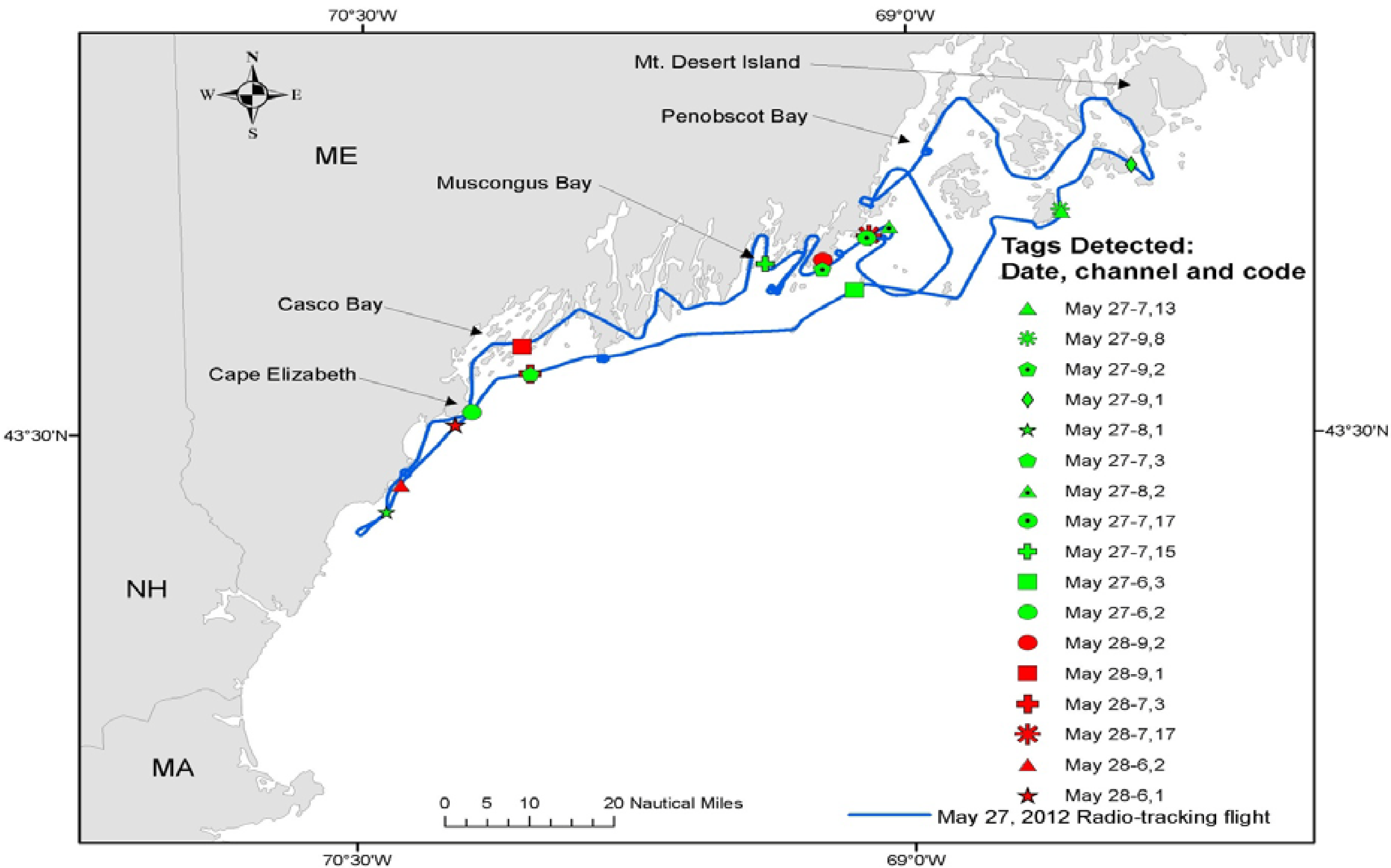


Figure D2. Loop pattern flown by the USFWS Kodiak for detecting radio tagged harbor seals, and 27 – 28 May 2012 detections.



Appendix E: *Abundance Estimates: Northeast and Southeast Fisheries Science Center*

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SUMMARY
During 2011 and 2012 staff of the Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC) of NOAA Fisheries Service analyzed the two-independent team line-transect shipboard and aerial AMAPPS data which were collected during 2011. Mark-recapture distance sampling analysis methods were used to estimate the abundance of cetaceans. The staff time to conduct these analyses was funded by NOAA Fisheries Science and the AMAPPS funds. Overall, nearly 435,000 cetaceans of 19 species (or species groups) were estimated to be present in the study area. These estimates are reported in the draft 2013 Marine Mammal Stock Assessment Reports (SARs), as mandated by the Marine Mammal Protection Act (MMPA). These SAR reports will be available for public review during the spring or summer of 2013.

METHODS
During June – August 2011, as part of the AMAPPS project, the Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC) of NOAA Fisheries Service conducted line-transect aerial and shipboard abundance surveys (Figure E1). One of the objectives of these surveys was to estimate the abundance of cetaceans and sea turtles in the northwestern Atlantic Ocean. To address this objective, during 2011 and 2012 staff from the NEFSC and SEFSC analyzed the two-independent team line transect shipboard and aerial data with mark-recapture distance sampling analysis methods to estimate the abundance of cetaceans. For most cetacean species, estimates of abundance were based on the independent observer approach assuming point independence (Laake and Borchers 2004) and calculated using the mark-recapture distance sampling option in the computer program Distance (version 6.0, release 2, Thomas *et al.* 2009).

RESULTS
The combination of the shipboard and aerial surveys conducted by both science centers covered waters in the US economic exclusive zone (EEZ), that is from the shore line to about 370 km (200 nmi) offshore. In addition, some Canadian waters were surveyed in the Gulf of Maine and Bay of Fundy (Figure E1). In a study area of about 463,000 km^2, the NEFSC surveys covered over 9100 km of track lines in waters from offshore of Virginia to the lower Bay of Fundy to as far east as 65°W. The SEFSC surveys covered about 4445 km of track lines in waters from the southern tip of Florida to New Jersey.

The shipboard and aerial line-transect data were collected following the two-independent team method. For more details of the NEFSC data collection and analysis methods refer to Palka (2012). The full documentation of the SEFSC analyses is currently in preparation.

Overall, nearly 435,000 cetaceans of 19 species (or species groups) were estimated to be present in the study area (Table E1). Abundance estimates for the surveyed area ranged from 300 – 400 animals per species of false killer whales (*Pseudorca crassidens*), humpback whales (*Megaptera novaeangliae*), rough-toothed dolphins (*Steno bredanensis*), and sei whales (*Balaenoptera borealis*), to over 50,000 animals per species of common bottlenose dolphins (*Tursiops truncatus*) short-beaked common dolphins (*Delphinus delphis*), harbor porpoises (*Phocoena phocoena*), and striped dolphins (*Stenella coeruleoalba*).

These estimates are reported in the draft 2013 Marine Mammal Stock Assessment Reports (SARs), as mandated by the Marine Mammal Protection Act (MMPA). These reports will be available for public review during the spring-summer of 2013.

ACKNOWLEDGMENTS

The 2011 summer line-transect shipboard and survey data were funded by the Bureau of Ocean Energy Management (BOEM) and the US Navy through the respective Interagency Agreements for the AMAPPS project. The analyses of these data were conducted by staff from and mostly funded by NOAA Fisheries NEFSC and SEFSC with some funds from BOEM.

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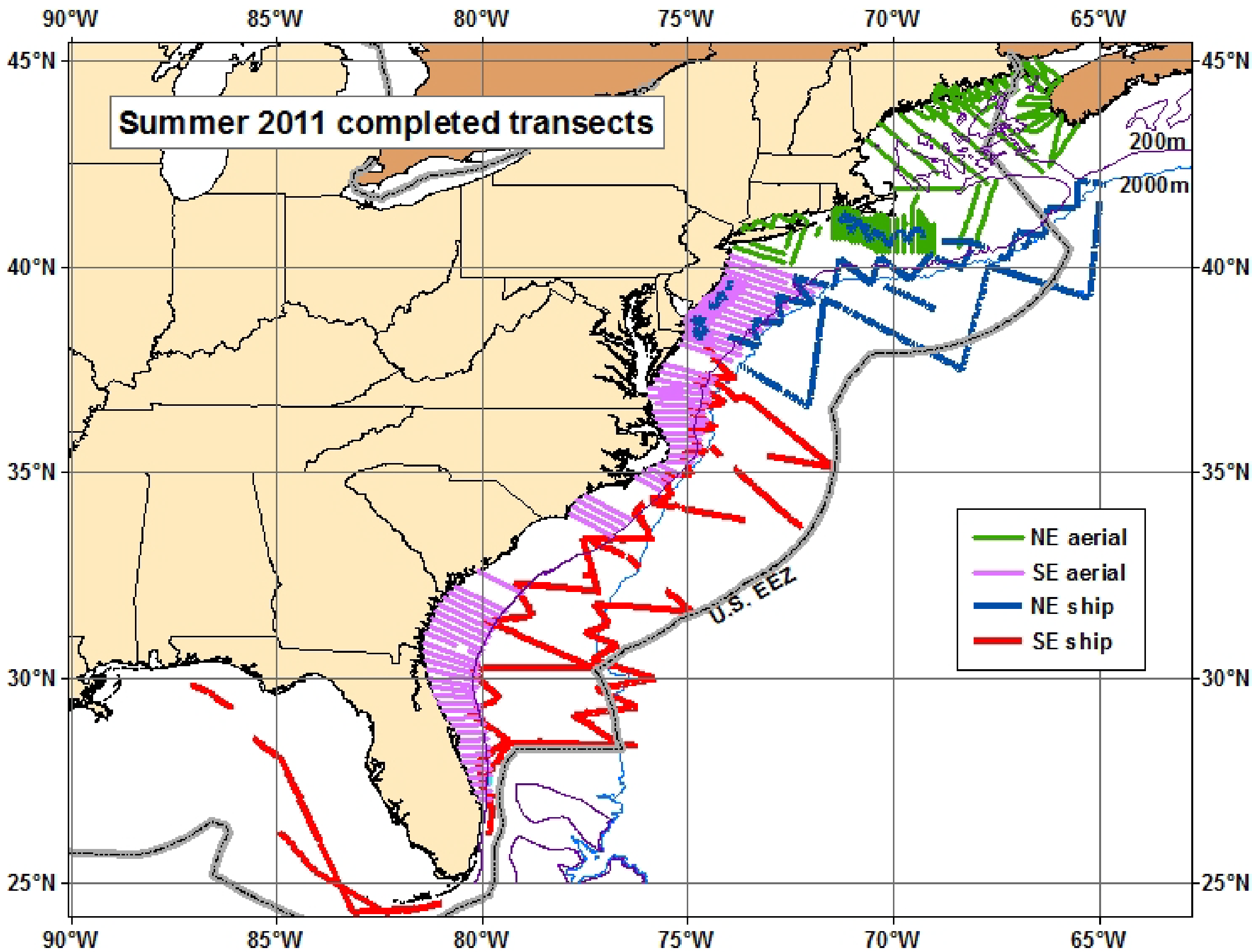
Palka D. 2012. Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2011 line transect survey. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 12-29; 37 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online http://www.nefsc.noaa.gov/nefsc/publications/

Thomas L, Laake JL, Rexstad E, Strindberg S, Marques FFC, Buckland ST, Borchers DL, Anderson DR, Burnham KP, Burt ML, Hedley SL, Pollard JH, Bishop JRB, Marques TA. 2009. Distance 6.0. Release 2. [Internet]. University of St. Andrews (UK): Research Unit for Wildlife Population Assessment. Available from: http://www.ruwpa.st-and.ac.uk/distance/

Table E1. Preliminary abundance (abun) and coefficient of variation (CV) of cetacean species derived from the 2011 shipboard and aerial surveys conducted by the Northeast Fisheries Science Center (NE) and Southeast Fisheries Science Center (SE).

	NE		SE			
Species	Abun	CV(Abun)	Abun	CV(Abun)	Total abun	CV(Total abun)
Atlantic spotted dolphin	26,798	0.66	17,917	0.42	44,715	0.43
Common bottlenose dolphin	26,766	0.52	50,766	0.55	77,532	0.40
Common dolphin	67,191	0.29	2,993	0.87	70,184	0.28
Cuvier's beaked whale	4,962	0.37	1,570	0.65	6,532	0.32
False killer whale	0	0	442	1.06	442	1.06
Fin whale	1,595	0.33	23	0.76	1,618	0.33
Harbor porpoise	79,883	0.32	0	0	79,883	0.32
Humpback whale	335	0.42	0	0	335	0.42
Kogia spp.	1783	0.62	2,002	0.69	3,785	0.47
Mesoplodonts spp.	5,500	0.67	1,592	0.67	7,092	0.54
Minke whale	2,591	0.81	0	0	2,591	0.81
Pantropical spotted dolphin	0	0	3,333	0.91	3,333	0.91
Pilot whale spp.	11,865	0.57			11,865	0.57
Risso's dolphin	15,197	0.55	3,053	0.44	18,250	0.46
Rough-toothed dolphin	48	0	271	1.00	319	0.85
Sei whale	357	0.52	0	0	357	0.52
Sperm whale	1,593	0.36	695	0.39	2,288	0.28
Striped dolphin	46,882	0.33	7,925	0.66	54,807	0.30
White-sided dolphin	48,819	0.61	0	0	48,819	0.61
Total	**342,165**	**0.15**	**92,582**	**0.32**	**434,747**	**0.14**

Figure E1. Completed tracklines used in the 2011 abundance estimates as conducted by airplane (green and purple lines) and ship (blue and red).



Appendix F: *Analyses of Passive Acoustic Data: Northeast Fisheries Science Center*

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SUMMARY

The goal of the AMAPPS-related work conducted by the Northeast Fisheries Science Center's passive acoustic team is to collect acoustic data that complement the visual-based analyses of animal occurrence and abundance, particularly for species that spend a long time underwater and so may not be available to be detected by the visual survey. There are currently five ongoing projects that involve the towed hydrophone array data which were collected during the AMAPPS 2011 vessel survey on the *NOAA Ship Henry B. Bigelow*. These are: (1) the first-time characterization of the acoustic signals of Sowerby's beaked whales (*Mesoplodon bidens*) which has resulted in an in-review manuscript; (2) the determination of acoustic detection rates of sperm whales (*Physeter macrocephalus*) where the goal is to incorporate these into abundance estimates to account for availability bias; (3) the identification and extraction of acoustic records from encounters with seven delphinid species that are being used in the development of the whistle classifier ROCCA; (4) extraction of echolocation clicks from Risso's dolphins (*Grampus griseus*) for geographic comparisons and application towards automated click detectors, and (5) the documentation of the methods used to track marine mammals using a hydrophone array that has resulted in the production of a chapter of a book (currently in review). In addition, in collaboration with scientists from each of the NOAA Science Centers, a new towed hydrophone array was constructed for future shipboard surveys. Finally, in collaboration with colleagues at Scripps Institution of Oceanography and the other NOAA Science Centers, an acoustic database is currently being developed to house processed data analyses in a standardized format. AMAPPS data will be included in this database.

METHODS

During the 2011 NEFSC AMAPPS abundance shipboard survey, passive acoustic data were collected whenever the visual sighting teams were searching, except for 15 hrs when the acoustic array needed maintenance and for the few days when the surveying was conducted in waters considered too shallow for safe deployment. These passive acoustic data were collected via one of two different oil-filled towed hydrophone arrays, towed 300 m behind the vessel. The arrays were comprised of several mid-frequency elements sampling at a rate of 192 kHz. More details on the data collection are in NEFSC & SEFSC (2011).

Post-processing of acoustic data took place using a variety of software packages. Automated detection and tracking of beaked whales and sperm whales (*Physeter macrocephalus*) were conducted using Pamguard (version 1.12.01 Beta, Gillespie et al. 2008). Sowerby's beaked whale (*Mesoplodon bidens*) echolocation clicks were characterized using custom-written Matlab (version 2010a, Mathworks, Inc.) code. Visual and aural reviews of spectrograms and extraction of delphinid whistles were conducted using the software packages Raven (version 1.4, Bioacoustics Research Program 2011) and Xbat (Figueroa and Robbins 2008), executed in Matlab. Risso's dolphin (*Grampus griseus*) clicks were extracted using the package Triton (version 1.6, Scripps Institution of Oceanography) and custom-written Matlab code.

RESULTS

Five acoustic projects are currently ongoing that use the towed hydrophone array data collected during the AMAPPS 2011 shipboard survey on the *NOAA Ship Henry B. Bigelow*. On that survey over 311 hours of acoustic data were collected across 40 days, resulting in 356 real-time detections of vocally-active groups of cetaceans.

Beaked Whale Acoustic Detection

During the AMAPPS 2011 survey, an encounter with a group of Sowerby's beaked whales created a first time opportunity to integrate acoustic recordings with visual confirmation of this species. As this species had never been described acoustically, post-processing analyses included three stages. First, over 4000 echolocation clicks were analyzed to characterize the spectral and temporal features the clicks (Figure F1). This work was conducted in collaboration with Dr. Simone Baumann-Pickering at the Scripps Institute of Oceanography, and contributes to a growing body of knowledge about the poorly-known beaked whale taxa. Second, based on the characterizations of the acoustic features of the echolocation clicks from this species, an automated click detector was developed within the software platform Pamguard (Figure F2). Current analyses include evaluating the efficacy of this detector across multiple encounters, with the goal of assessing the acoustic detection rate of Sowerby's beaked whales. Finally, we are applying three-dimensional localization techniques to describe the depths at which individual animals were vocalizing. This will be useful both for comparison with other species, as well as to assess the impact of animal depth on abundance estimates. The first stage of this work was submitted to and is currently in revision at the *Journal of the Acoustical Society of America*:

> Cholewiak D, Baumann-Pickering S, Van Parijs SM. Description of sounds associated with Sowerby's beaked whales (*Mesoplodon bidens*) in the western North Atlantic.

Sperm Whale Acoustic Detection

Sperm whales were detected acoustically on over 30 days during the AMAPPS 2011 survey. Analyses conducted in 2012 involved quantifying the acoustic detection rate of sperm whale individuals and groups, with the goal of incorporating these acoustic data into abundance estimates. The software package Pamguard was used to apply specialized click detectors to quantify the number of acoustic encounter events, and two-dimensional localization algorithms are being used to track individual animals. After this is complete, it is our plan to pair this information with the visual abundance data to result in a more accurate abundance estimate of sperm whales.

Delphinid Whistle Classification

An algorithm for classifying delphinid whistles to species (ROCCA) is currently being developed in collaboration with Dr. Julie Oswald (from Biowaves). Analyses in 2012 involved identifying and extracting acoustic records from visually-confirmed encounters with single-species delphinid groups, which will be used for the training and testing of this classifier. All visual sightings from the NE AMAPPS 2011 survey were reviewed to identify encounters that met specific criteria for acoustic analyses (including: distance from vessel, distance to other groups, visual sighting conditions, etc.). Twenty-eight encounters with seven different species were chosen. Over 1200 whistles were extracted and provided to Dr. Oswald for development of ROCCA (Table F1). The current version of ROCCA will be implemented and tested during the AMAPPS 2013 shipboard survey.

Echolocation Classification: Risso's Dolphins

Acoustic classification of dolphin species using echolocation clicks is a newly developing field. An analysis is currently underway with collaborators at several NOAA Science Centers and Scripps Institution of Oceanography to document the spectral characteristics and geographic variation in the echolocation patterns of Risso's dolphins. This will be useful for the application of classification algorithms to previous and future AMAPPS data. All visually-confirmed encounters with Risso's dolphins occurring within 3 km of the vessel during the NE AMAPPS 2011 survey were reviewed; six encounters with this species were chosen for analysis. Over 1000 echolocation clicks were extracted; analyses are in process.

Documenting Acoustic Tracking of Cetaceans and Considerations for Density Estimation

For integration of passive acoustic data into estimates of animal abundance or density, two of the key pieces of information that are needed are the calling rates of individual animals and the probability of acoustic detection. Data collected from the NE AMAPPS 2011 survey were used to document the methodology and considerations necessary for tracking cetaceans using hydrophone arrays. This has resulted in the following paper which was submitted as an invited book chapter on current research in passive acoustics, which was in conjunction with the Detection, Classification, Localization and Density Estimation Workshop:

> Cholewiak D, Risch D, Valtierra R, Van Parijs SM. Methods for passive acoustic tracking of marine mammals: estimating calling rates, depths and detection probability for density estimation.

Hydrophone Array Construction

During 2012, we worked with scientists from each of the NOAA Science Centers to develop a standardized hydrophone array system that will be used on future shipboard surveys across the Centers. Primary array construction was conducted in October/November 2012, and will be finalized in spring of 2013. The array is modular and includes two active sections separated by 30 m, to facilitate improved localization ability. Custom-designed hardware was developed to produce robust, load-bearing underwater connection systems. The array includes five mid-frequency and two high-frequency hydrophones, as well as a depth sensor. Thus, it has the capability to detect and localize delphinids as well as high-frequency species such as *Kogia spp.* and harbor porpoises. This will be the main array used during the AMAPPS 2013 shipboard survey.

DISPOSITION OF DATA

Acoustic data are stored on-site at the Northeast Fisheries Science Center. In 2012, representatives of all of the NOAA Science Centers and colleagues at Scripps Institution of Oceanography participated in the development of an acoustic database system. When completed, this database will allow for standardized archival of acoustic analysis products, including those from the AMAPPS surveys.

ACKNOWLEDGEMENTS

The Bureau of Ocean Energy Management (BOEM) and the US Navy through two Interagency Agreements for the AMAPPS project provided the funds for the 2011 summer acoustic data collection and partially funded the 2012 projects. Funding for analysis time was also provided by the Navy's Living Marine Resources Program. Funding for the construction of the hydrophone array was also provided in part by NOAA's Advance Science and Technology Working Group.

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Northeast Fisheries Science Center (NEFSC), Southeast Fisheries Science Center (SEFSC). 2011. 2010 Annual Report to the Inter-Agency Agreement M10PG00075/0001: A Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in US Waters of the western North Atlantic Ocean or online at http://www.nefsc.noaa.gov/psb/AMAPPS/docs/Final_2010AnnualReportAMAPPS_19Apr2011.pdf

Table F1. Species and number of whistles that were provided to Dr. Oswald for the development of ROCCA, an automated whistle classifier, which is currently being customized for delphinid species in the western North Atlantic Ocean.

Species name	Common name	Whistles extracted
Globicephala spp.	Pilot whale	63
Grampus griseus	Risso's dolphin	144
Delphinus delphis	Common dolphin	254
Stenella frontalis	Atlantic spotted dolphin	167
Tursiops truncatus	Bottlenose dolphin	135
Stenella coeruleoalba	Striped dolphin	398
Steno bredanensis	Rough-toothed dolphin	71
Total		**1232**

Figure F1. Sowerby's beaked whale (*Mesoplodon bidens*) echolocation clicks, recorded during the NE AMAPPS 2011 survey. Waveform (upper panel) and spectrogram (lower panel).

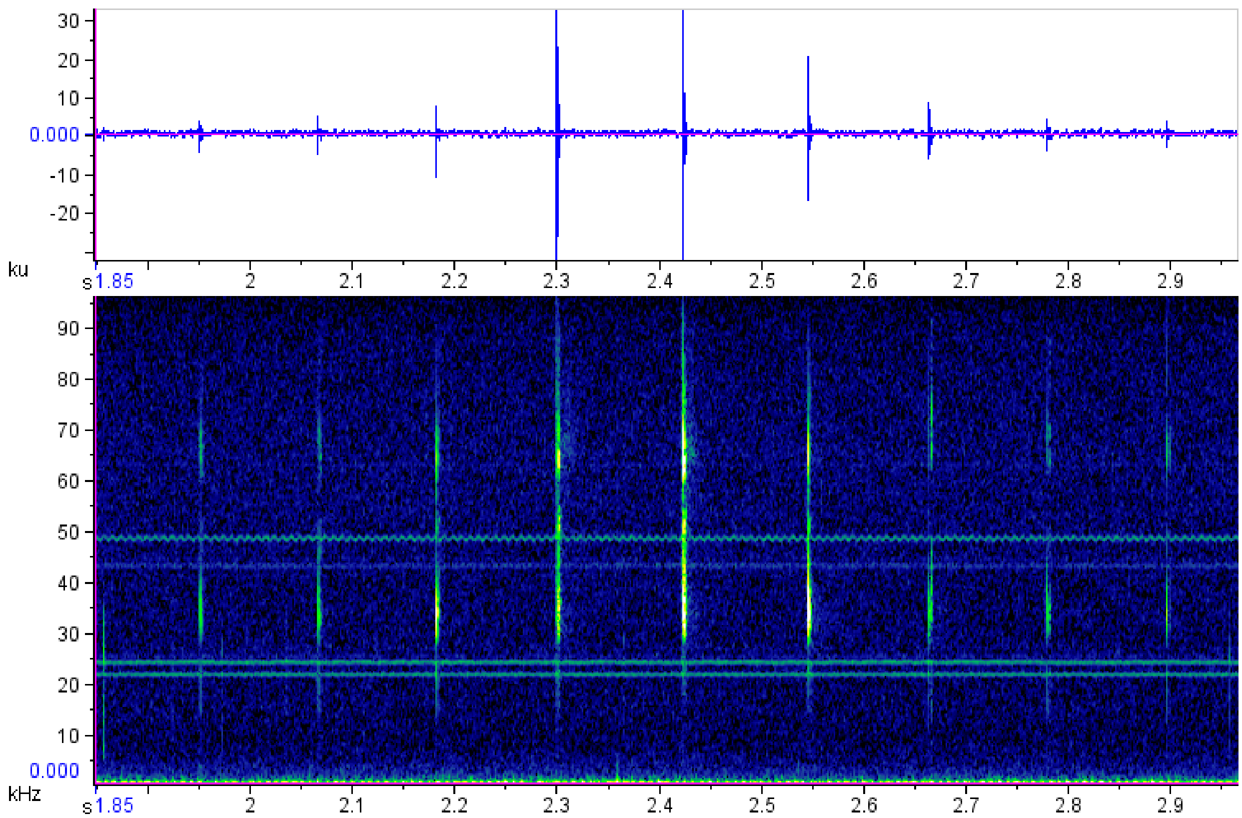
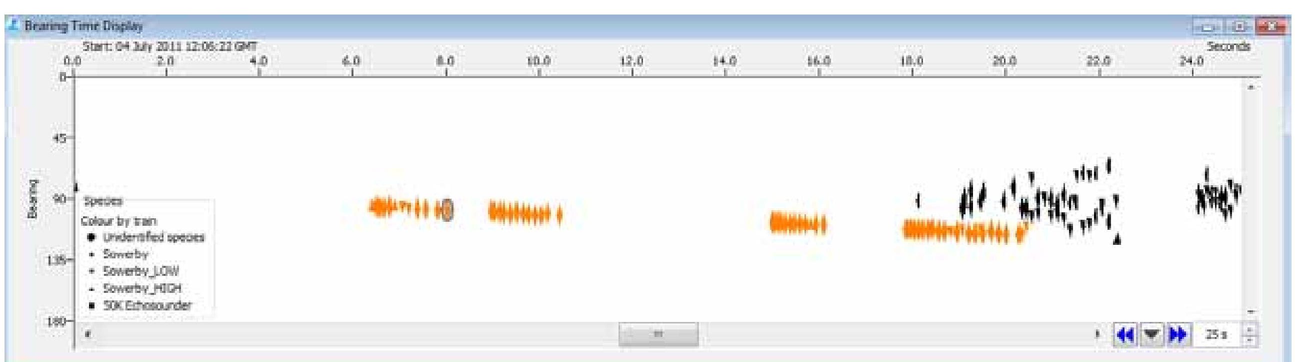


Figure F2. Bearing-time plot from Pamguard, showing detection of echolocation clicks during an encounter with Sowerby's beaked whales (*Mesoplodon bidens*). Each symbol indicates a detected click; the orange symbols indicate a series that were assigned to a click train from one individual as it was passed by the ship.



Appendix G*:* *Analyses of Active Acoustic, Hydrographic and Plankton Data: Northeast Fisheries Science Center*

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SUMMARY

To understand how environmental habitat characteristics can influence the distribution and density of the marine mammals, sea turtles and sea birds, and to attempt to discriminate between the changes in cetacean populations due to natural environmental variability versus changes due to anthropogenic impacts, it is useful to have an understanding of what physical and biological characteristics are currently associated with the density and distribution of marine mammals, sea turtles and sea birds. The objective of this project is to document the hydrographic characteristics of the water column relative to distribution patterns of organisms. The first organisms to be explored are those found in the active acoustic back scatter data which are generally in the 2 mm – 5 cm size range and correspond to the middle and lower level trophic taxa. Next, in the near future, plankton as detected from the visual plankton recorder (VPR) and bongo sample analyses will be investigated. Then all of the distributions and relative density patterns of the hydrography and lower trophic level organisms will be compared to the marine mammal distributions.

BACKGOUND AND OBJECTIVES

One of the objectives of the AMAPPS initiative is to develop spatially explicit density maps of cetaceans, sea turtles and sea birds that incorporate environmental habitat characteristics. To understand how environmental habitat characteristics relate to the distribution and density of these animals, to forecast animal density maps to a future time when environmental conditions may change, and to discriminate between changes in cetacean populations due to natural environmental variability and changes due to anthropogenic impacts, it is useful to understand what physical and biological characteristics are currently associated with the density and distribution of these animals. One way to attempt to understand this is to compare the distribution and density patterns of marine mammals, sea turtles and sea birds with the patterns of other trophic levels and patterns of the physical environment. Hydrographic data, active acoustic data and plankton data were collected during the 2011 AMAPPS NEFSC survey to start this exploration. The first objective of this project is to compare the hydrographic characteristics of the water column to the distribution and density patterns of the 2 mm – 5 cm size ranged organisms seen in the active acoustic backscatter data, which correspond to the middle and lower level trophic taxa. The next step would be to compare these relationships to the marine mammal distribution patterns and determine the utility of different modeling covariates generated from these relationships

This is a cooperative project. The 2011 data collection was funded by the AMAPPS funds. Data processing and analysis of the hydrographic and plankton data during 2012 was conducted by and funded by the Northeast Fisheries Science Center. In addition, the 2012 data processing and analyses of the hydrographic and active acoustic data were conducted a Ph.D. student at Duke University funded through the WHOI-Duke Fellowship in Marine Conservation, the Oak Foundation and the Nancy Foster Scholarship Program.

A major hydrographic characteristic within the Middle Atlantic Bight (MAB; that is, coastal waters between Massachusetts and North Carolina) is the MAB shelfbreak front. The MAB shelfbreak front is known to be a site of enhanced primary productivity in part because of upwelling driven by a bottom boundary layer convergence (Houghton and Visbec 1998, Gawarkiewicz and Chapman 1992). The persistent upwelling has attracted attention as a possible mechanism driving the distribution of middle trophic level taxa and possibly the distribution of higher trophic level predators, including cetaceans, seabirds and sea turtles. The MAB shelfbreak front separates the coastal cool, lower salinity continental shelf water from the offshore warm, higher salinity continental slope water (Linder and Gawarkiewicz 1998). The cool pool water (< 10°C) is a remnant of a water mass formed during winter months when temperatures are cooler and vertical mixing is strong. During the formation of the seasonal thermocline in the summer, the cool pool of water becomes trapped on the shelf bottom and is thus isolated from atmospheric influences. The offshore upper slope water is also the result of season atmospheric influence and is defined by temperature > 12°C and salinity > 35.2 parts per thousand (ppt).

METHODS

On the Northeast Fisheries Science Center's (NEFSC) shipboard survey physical water characteristics and distribution and densities of various trophic levels were documented using the Simrad EK60, Sippican T-7 Expendable Bathythermograph (XBT), a Video Plankton Recorder (VPR), bongo tow nets, visual surveying, and passive acoustic monitoring. This objective of this project is focused on the samples from all but the last two. Acoustic backscatter data collected from the ship's Simrad EK60 multi-frequency scientific echosounder system were used to target biological layers and select plankton sampling locations. Plankton tows were made as close as possible to the visual team's transect lines using a Seascan V-fin mounted, internally recording, black and white VPR. Bongo samples were collected along the transect line three times daily and a hydrographic cast was made at the start and end of each day's line. Sippican T-7 XBT probes were launched to record temperature profiles during four shelf break crossings. Each type of data is being processed and will be geo-references so that the spatial patterns of each can be compared to each other.

XBT data

Sippican T-7 XBT probes were launched on the third leg of the cruise to record temperature profiles during four shelfbreak crossings (Figure G1; NEFSC and SEFSC 2011). The XBT records the temperature and depth of the water that the XBT travels through. The XBT data collected on a straight track line were use to create a two-dimensional temperature-depth profile of that track line. Additional analyses are ongoing to project the data in an accurate orthogonal shelfbreak representation and to determine the width of the MAB frontal zone.

EK60 hydro-acoustic data

The ship's Simrad EK60 multi-frequency echosounder system was operational every night after marine mammal operations ended and during the daytime every other day when the marine mammal teams were on-effort. The EK60 system consisted of five frequencies (18, 38, 70, 120, and 200 kHz) that synchronously emitted pings and recorded returned acoustic backscatter. More data collection details are in (NEFSC and SEFSC 2011).

After the survey the EK60 active acoustics data were prepared for analysis. This involved developing and implementing algorithms to clean the 5-frequency data including automating a bottom line detection over steep topography, removing background noise, and removing spike noise from the ADCP. These algorithms will be turned into templates which could then be used to process EK60 hydro-acoustic data from other surveys, for example the 2011 SE AMAPPS survey and the upcoming 2013 NE and SE AMAPPS shipboard surveys.

VPR data

During the nighttime hours, 81 plankton tows were made as close as possible to the visual team's transect lines using a Seascan V-fin mounted, internally recording, black and white VPR. The VPR was also equipped with a Seabird Fastcat CTD, a Wetlabs fluorometer / turbidity sensor and a Benthos altimeter. A second SEACAT 911 CTD profiler was mounted above the V-fin and connected to the 322 conducting core cable to provide real time data on gear depth and oceanographic conditions. More data collection details are in (NEFSC and SEFSC 2011).

Upon retrieval, the data were downloaded to one of three computers in the ships chemical lab for processing. Focused regions of interest (ROIs) were extracted from each image frame using Autodeck programming from Seascan. Profiles of temperature, salinity, density, raw chlorophyll and raw turbidity values were created for each tow using MATLAB. Plankton ROIs were processed to remove air bubbles and duplicate images. ROIs have been identified to general taxonomic grouping using a modified version of Visual Plankton developed by Cabell Davis of the Woods Hole Oceanographic Institution.

During 2011 and 2012, the VPR plankton images were re-processed using an improved version of the Autodeck program.

Bongo data

A 61 cm bongo plankton frame was equipped with one 333 μm and one 505 μm mesh net and a CTD mounted on the wire 1 m above the nets. The bongo was deployed approximately three times a day: once before the day's surveying started (about 0500 – 0530), at lunch time (about 1200 when the ship stopped surveying), and again after surveying was completed for the day (approximately 1800, depending on weather and timing of the sunset). More data collection details are in (NEFSC and SEFSC 2011).

During 2012, the samples were shipped to the Polish processing laboratory where the plankton in the jars were identified to species or (species group) and enumerated.

RESULTS

XBT data

Analysis of the XBT data (Figure G2) shows the general thermal structure of the four track lines. As seen in Figure G1, the XBT sampling locations are not orthogonal to the shelfbreak and have not yet been projected to represent a shelfbreak crossing. These property plots should be considered preliminary. The cold pool (8 – 10°C) is prominent in all sections, however, it is diminished on Trackline 07 because of the shoreward intrusion of a warm core ring. In all sections, the shelfbreak front (9 – 10°C) intersects the shelf at approximately the 100 – 125 m depth isobaths, but the furthest shoreward extent of the front is not known due to the track line's limited onshore extent. In all track lines, the slopes of the frontal isotherms were offshore, which is consistent with what is known about the climatological position of the front (Linder and Gawarkiewicz 1998).

EK60 hydro-acoustic data

Although not fully analyzed, the active acoustic data show interesting biological patches around the shelfbreak and at the canyons. It was thought that these types of patches would also be in the vicinity of the shelfbreak front due to the properties of the jet associated with the front. However, the biological patches appear to be deeper than the climatological position of the shelfbreak front. Full analysis of these data will determine the position of biological patches and layers in relation the shelfbreak front as it was during the 2011 survey.

VPR data

A total of 81 VPR with CTD tows were conducted (Figure G3) along the track lines that were surveyed visually by the marine mammal and sea bird observers and acoustically by the passive acoustic monitors.

Oceanographic data from the undulating VPR tows have been plotted to further characterize the shelf slope boundary. Tracklines crossing the shelf/slope boundary were difficult to conduct on a regular schedule due to the amount of fixed gear (long line and lobster pots) found in this environment. A typical Mid Atlantic Bight frontal station (Figure G4) was characterized by a moderate thermocline at about 35 m depth and indications of slope water in the tidal front below 80 m depth. Cholophyll and turbidity counts were highest just below the thermocline.

Plankton was plentiful at the shelf slope front and was characterized by distinct layers. Gelatinous zooplankton such as ctenphores and salps were seen in the top 10 m while smaller plankton like copepoda, pteropda, and larger phytoplankton were found in and just below the thermocline. Plankton densities decreased significantly below the thermocline where crustaceans where the most common taxa and plankton size tended to increase. Plankton densities in water characterized as slope water were extremely low.

Future analyses include comparing the VPR plankton counts and biovolume estimates to the 120 and 200 kHz EK60 data to begin to quantify signal strength into realistic plankton densities. This comparison has the potential to greatly increase the geographic area of the survey which includes plankton distribution data.

Bongo data

A total of 90 double oblique bongo hauls with a CTD were conducted (Figure G3) along the track lines that were surveyed visually by the marine mammal and sea bird observers and acoustically by the passive acoustic monitors.

Plankton species were identified and counted for 85 of the bongo hauls. These data are still being processed so summaries are currently not available.

ACKNOWLEDGEMENTS

The data collection was funded by the Bureau of Ocean Energy Management (BOEM) and the US Navy through two Interagency Agreements for the AMAPPS project and by the NOAA Fisheries Service. Data processing and analysis of the plankton data was funded by the Northeast Fisheries Science Center. In addition, the data processing and analyses of the hydrographic and hydro-acoustic data was primarily funded by the Nancy Foster Scholarship Program with additional support from the Oak Foundation (XBTs), and the WHOI-Duke Fellowship in Marine Conservation.

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Figure G1. Location of XBT launches.

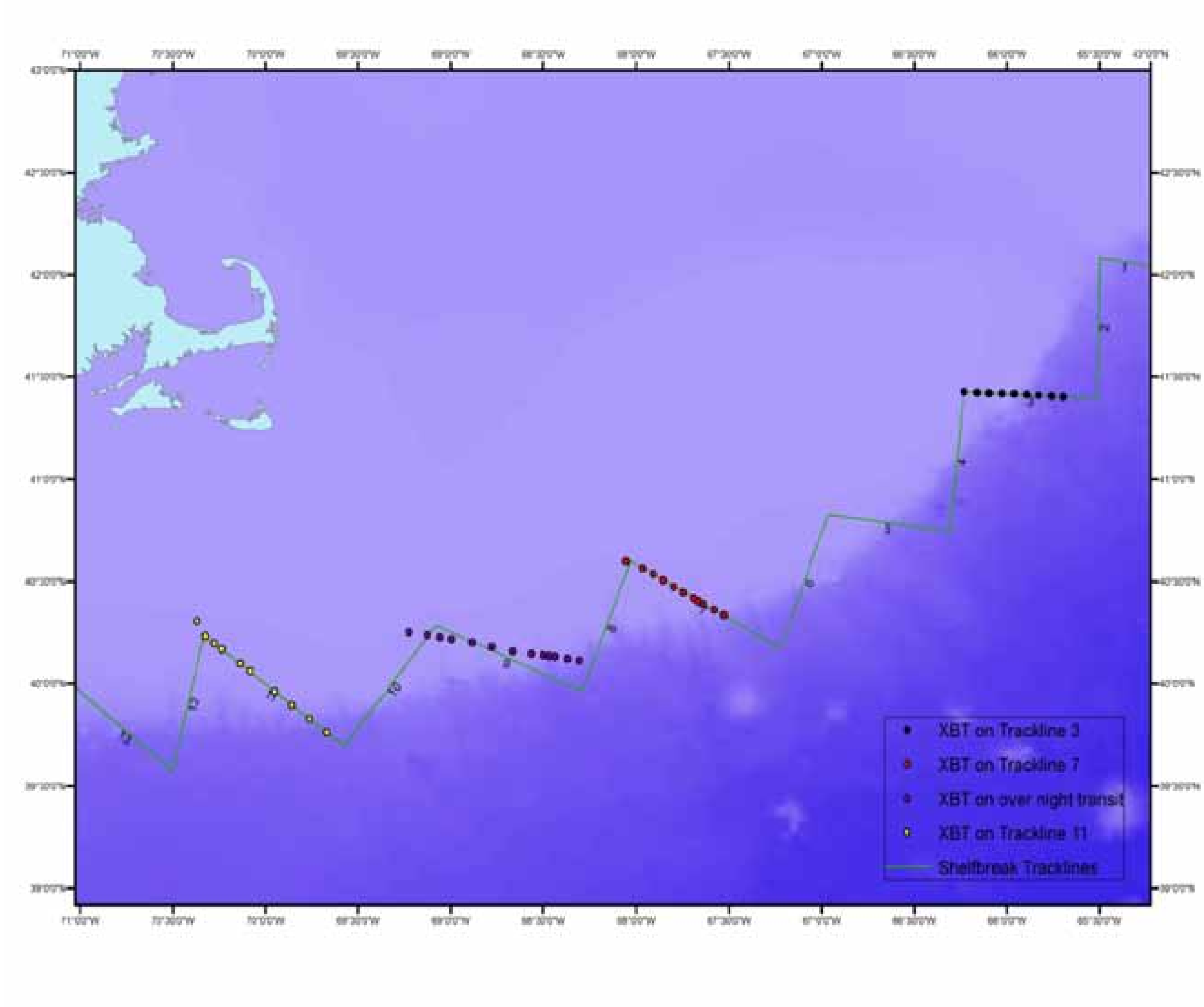


Figure G2. Temperture (^oC) sections. The position of each XBT station is marked with an asterisk (*).

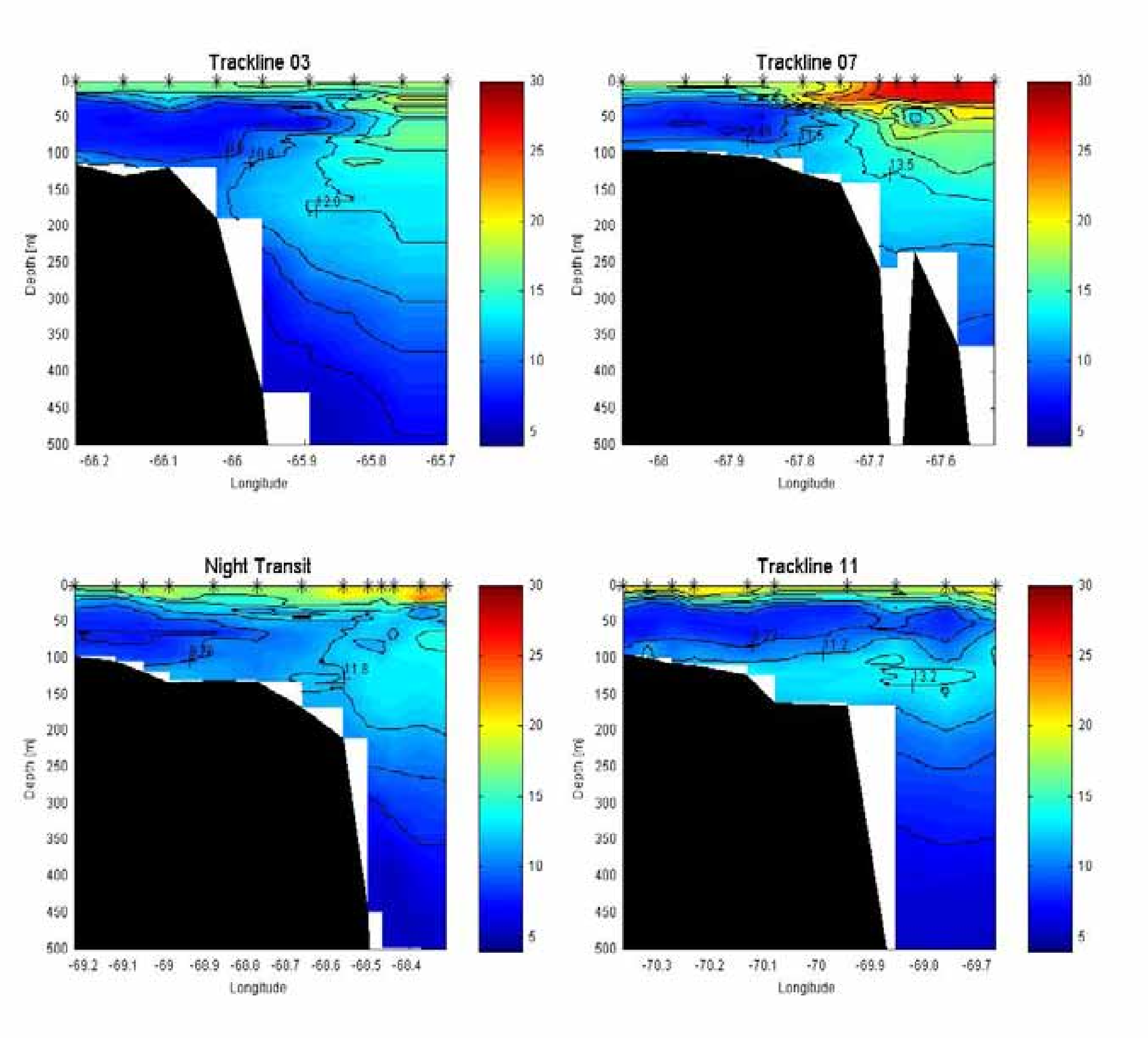


Figure G3. Location of the bongo, VPR and CTD sampling stations (colored dots) and track lines that were surveyed by the marine mammal and seabird observers and monitors (line).

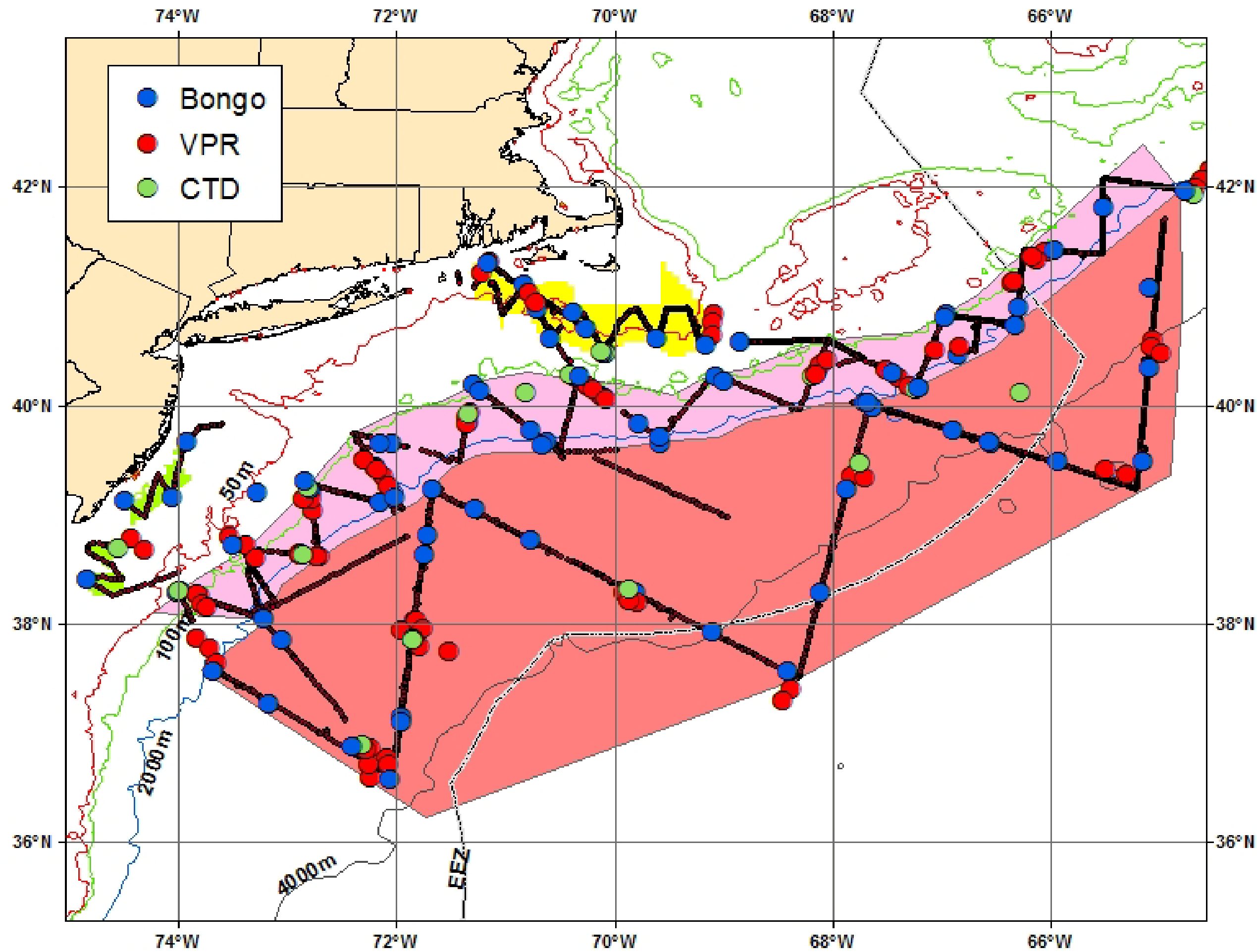
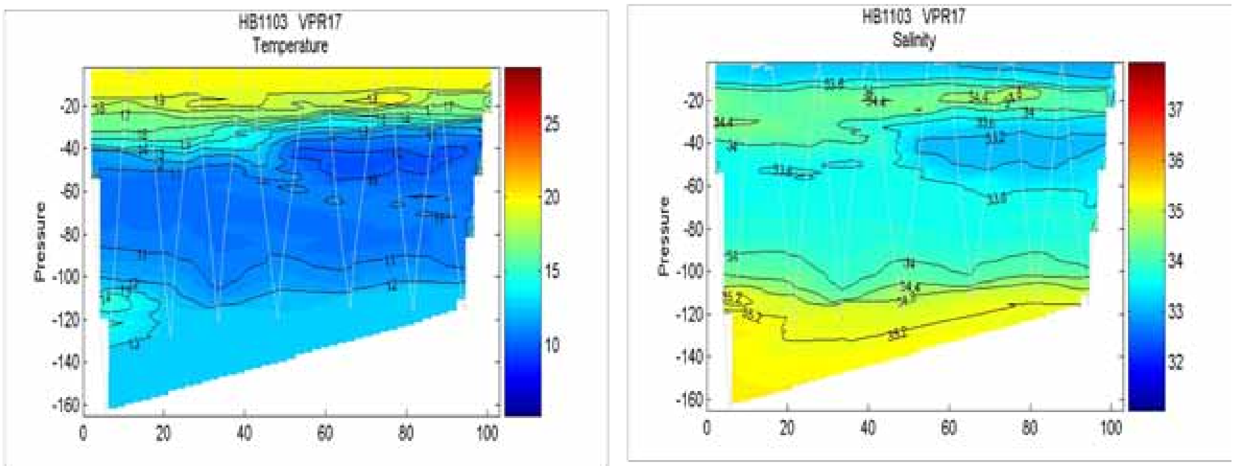
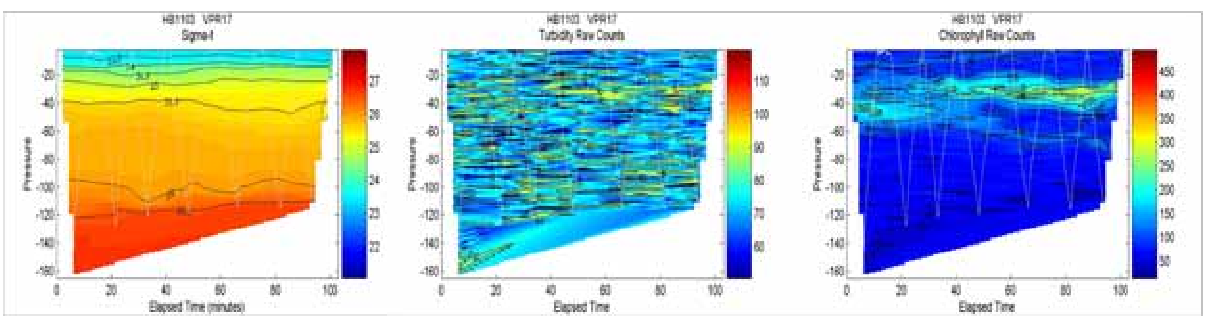


Figure G4. Temperature (ºC), salinity (psu), density (sigma-t), turbidity and fluorescence at a typical Mid-Atlantic Bight shelf/slope station as measured by the visual plankton recorder (VPR). The path traveled by the VPR is the white line superimposed on the plot.



Station 18



Appendix H: *Estimation of oceanic stage duration for loggerhead sea turtles: Southeast Fisheries Science Center*

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SUMMARY
To estimate the population size of loggerhead turtles (*Caretta caretta*), the data collected during the AMAPPS aerial abundance surveys that covered the US continental shelf waters need to be corrected for the animals not available to the aerial survey observers. These unavailable animals include those animals that were within the study area but were underwater (addressed under the project described in Appendix C: Northern Sea Turtle Tagging Project: Northeast Fisheries Science Center), and those animals that were not in the study area during the timing of the abundance survey (addressed under the project described in this Appendix). The objective of this project is to combine skeleto-chronological and stable isotope analyses of annually formed skeletal growth marks (GMs) in juvenile North Atlantic loggerhead sea turtle humeri to refine estimates of the number of young age classes that have not yet entered the habitats along the east coast of the US, where the aerial abundance surveys are being conducted. From stranded loggerheads that were collected during 1996 – 2010, a total of 246 humeri from oceanic (*n* = 22, Azores Islands) and neritic (*n* = 224, U.S. Atlantic coast) loggerheads were analyzed. Carbon and nitrogen stable isotope values were obtained from 109 GM-specific bone dust samples which were from a sub-set of 15 humeri from neritic juveniles stranded in North Carolina's inshore waters during 1978 – 2008. Based on the transition SCLs associated with the δ^{15}N results, spline fits yielded mean oceanic stage duration estimates of 12 – 13 yrs at 55.3 cm SCL, mean minima of 8 – 10 yr at 43.9 cm SCL, and mean maxima of 16 – 19 yrs at 67.2 cm SCL. These estimates differ from those previously reported for loggerheads in the western North Atlantic, likely because samples in earlier studies consisted solely of either oceanic or neritic samples and were unable to account for the allometric relationship between humerus and SCL measures. A manuscript describing this study and its findings is currently in review for publication in *Marine Ecology Progress Series*.

BACKGOUND AND OBJECTIVES
The Atlantic Marine Assessment Program for Protected Species (AMAPPS) aerial abundance surveys are conducted on the continental shelf waters from the US east coast to about the 100 – 2000 m depth contours, depending on the location. These waters are considered to be part of the loggerhead turtles' (*Caretta caretta*) neritic life stage. However, many loggerheads are not in this life stage yet and thus not within the aerial survey study area. Before a loggerhead enters the neritic stage on the continental shelf waters, it is in the oceanic stage which is located in deeper waters within US and other countries territories. The objective of this project is to combine skeleto-chronological and stable isotope analyses of annually laid skeletal growth marks (GMs) in juvenile North Atlantic loggerhead sea turtle humeri to refine estimates of the duration spent in the oceanic stage. These data will allow assessment of the number of young age classes that have not yet entered the neritic stage in habitats along the east coast of the US, where the aerial abundance surveys are being conducted.

This project focused on loggerheads because this is the one species for which we have access to oceanic stage juveniles in the eastern North Atlantic and because of the continued concern over the decline in nest numbers and the potential change in Endangered Species Act (ESA) listing status from threatened to endangered. This project was funded by a combination of AMAPPS and National Marine Fisheries Service (NMFS) Stock Assessment Improvement Plan (SAIP) funds.

METHODS

The Southeast Fisheries Science Center (SEFSC) analyzed humeri from both oceanic and neritic stage juveniles. This was necessary because analyses solely of samples obtained from oceanic stage juveniles that have not yet completed the oceanic stage would only provide a minimum estimate of the oceanic stage duration. Conversely, the humeri of most neritic juveniles, who have left the oceanic stage, exhibit skeletal growth mark (GM) resorption, where early GMs are destroyed as bone is reconstructed during growth, eliminating the possibility of estimating the oceanic stage directly through GM counts of neritic stage juveniles. As a result, analysis of humeri from both oceanic and neritic stage juveniles is needed to address this question. To estimate the mean, range, and variability of the oceanic stage duration, the following steps were implemented:

1) Assess the GM spacing in neritic juvenile humeri to identify the GM potentially associated with the oceanic to neritic transition;
2) Validate the proposed transition points by sub-sampling the bone in the GM spaces and analyzing the carbon and nitrogen stable isotope signatures to assess potential shifts in isotope values which are due to the change in environment and prey species when the animal transitions from the oceanic stage to the neritic stage;
3) From neritic juvenile humeri obtain GM counts, as well as diameter measurements of GMs and the resorption cores (where early GMs have already been destroyed); and
4) Combine GM counts and diameter measurements from neritic juvenile humeri (3) with GM counts and diameter measurements from oceanic stage juveniles to model juvenile loggerhead age and growth.

RESULTS

From stranded loggerheads that were collected during 1996 – 2010, a total of 246 humeri from oceanic (*n* = 22, Azores Islands) and neritic (*n* = 224, U.S. Atlantic coast) loggerheads were analyzed. These animals ranged from 7.8 – 88.6 cm straight-line carapace length (SCL), where the mean SCL was 55.8 cm (± 15.8 cm). Of these 67 were females, 33 were males, and 146 were of unknown sex. Oceanic turtles ranged from 8.2 – 63.3 cm SCL (mean = 23.3 ± 17.7 cm SCL) and neritic turtles ranged from 7.8 – 88.6 cm SCL (mean = 59.0 ± 11.4 cm SCL).

Humeri were sectioned, histologically processed, and imaged according to the methods of Avens et al. (2012) to determine the GM number and placements, as well as measure the total diameter of each GM. To account for any GMs lost to resorption (Avens et al. 2012), correction factors were developed from the sub-set of humeri that had a diffuse GM consistent in appearance with the ‘annulus’ which denotes the end of the first year of growth in sea turtles.

Carbon and nitrogen stable isotope values were obtained from a sub-set of 15 humeri from neritic juveniles stranded in North Carolina’s inshore waters during 1978 – 2008 who ranged from 49.08 – 72.7 cm SCL (mean = 60.7 ± 6.7 cm SCL). An automated micro-milling system was programmed to drill the 109 line of arrested growth pairs, ensuring that each drill path corresponded to an individual, annual skeletal growth increment. The 15 humeri yielded 109 GM-specific bone dust samples, each of which was packed into a sterilized tin capsule and analyzed using a continuous-flow isotope-ratio mass spectrometer.

The relationship between humerus diameter and SCL was found to be allometric (Snover et al. 2007; Avens et al. 2012) and best- described by $L = L_{op} + b(D - D_{op})^c$, where L is the estimated SCL, L_{op} is the mean hatchling SCL, D is the humerus section diameter, D_{op} is the mean hatchling humerus diameter, b is the slope of the relationship, and c is the proportionality coefficient. The values of the mean hatchling humerus diameter (D_{op} = 1.9 mm) and SCL (L_{op} = 4.6 cm) for northwestern Atlantic loggerheads were taken from Snover et al. (2007). Thus, putting all the data together, b was estimated to be 3.109, and c was 0.936. The Body Proportional Hypothesis as modified for sea turtles (Snover et al. 2007) was applied to the allometric equation, to allow back-calculation of SCLs from GM diameters and the efficacy of this approach was tested using humeri from 12 neritic juvenile loggerheads tagged prior to stranding for which tagging histories were available. Assuming annual GM deposition, the GM deposited closest to the time of tagging was identified and the SCL estimated using that GM diameter was compared to SCL measured at tagging. No significant difference was found between estimated and measured SCLs (p=0.81, Wilcoxon signed rank test) and mean absolute difference was 1.1 cm SCL. This result validates the following: 1) the assumption of annual GM deposition; 2) back-calculation of SCL from GM diameter; and 3) back-calculation of somatic growth rates on annual time scales through conversion of sequential LAG diameters to SCL estimates.

Of the 15 humeri sub-sampled for stable isotopes, 8 exhibited a single, pronounced increase in nitrogen stable isotopes ($\delta^{15}N$) consistent with a shift from oceanic to neritic foraging and therefore SCL and age at transition was taken as that associated with the GM immediately preceding the $\delta^{15}N$ increase. Although bone samples from the 7 remaining turtles did not display an increase in $\delta^{15}N$, their presence in inshore waters indicated that the shift to neritic habitat had occurred and therefore the terminal SCL and age was associated with the transition. For this sub-set of turtles representing years spanning 1992 – 2006 (median = 2002), mean oceanic stage duration and size at neritic recruitment size at transition was 55.3 cm SCL ± 5.6 SD (range 43.9 – 67.2 cm SCL) and mean age of 12.4 yr ± 2 yr SD (range 9.75 – 15.75 yr).

Smoothing splines and 95% confidence intervals were fit to SCL and age estimate data and used to predict means and ranges of ages associated with sizes at transition which were indicated by the $\delta^{15}N$ results in this study. Spline fits revealed no significant differences between male and female SCL-at-age relationships in juvenile loggerheads. Based on the transition SCLs associated with the $\delta^{15}N$ results, spline fits yielded mean oceanic stage duration estimates of 12 – 13 yrs at 55.3 cm SCL, mean minima of 8 – 10 yr at 43.9 cm SCL, and mean maxima of 16 – 19 yrs at 67.2 cm SCL. These estimates differ from those previously reported for loggerheads in the western North Atlantic, likely because samples in earlier studies consisted solely of either oceanic (Bjorndal et al. 2003) or neritic (Snover 2002) samples and were unable to account for the allometric relationship between humerus and SCL measures (subsequently described in Snover et al. 2007).

Back-calculated annual growth rates represented the time period spanning 1984 – 2009 and were comparable to those yielded by previous mark-recapture studies of loggerheads populations in geographic areas overlapping with the scope of the current study. Generalized Additive Models (GAMs) and Generalized Additive Mixed Models (GAMMs) were applied to assess the potential influence of different covariates on somatic growth. Whereas the effects of age, SCL, calendar year, and trophic level (as inferred through $\delta^{15}N$ values) on growth rates were significant, no influence of sex and minimal influence of location were found.

For more details on this project a manuscript is currently in review for publication:

Avens L, Goshe LR, Pajuelo M, Bjorndal KA, MacDonald BD, Lemons GE, Bolten AB, Seminoff JA (*In review*) Complementary skeletochronology and stable isotope analyses offer new insight into juvenile loggerhead sea turtle oceanic stage duration and growth dynamics. *Marine Ecology Progress Series*

ACKNOWLEDGEMENTS

The funds for this project came from the Bureau of Ocean Energy Management (BOEM) and the US Navy through two Interagency Agreements for the AMAPPS project and NMFS Sea Turtle Stock Assessment Improvement Plan (SAIP) funds. This project was also supported by NMFS base funding and equipment associated with the NMFS National Sea Turtle Aging Laboratory.

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Appendix I: *Canadian Grand Banks sea turtle tagging study, 2010 – 2012: Southeast Fisheries Science Center*

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SUMMARY

Improved survival rates of oceanic juvenile loggerhead turtles (*Caretta caretta*) will allow better prediction of the recruitment of juveniles from their oceanic habitat to the neritic habitat, which is the region where the NMFS aerial surveys have observed and counted turtles. AMAPPS 2010 funds supplemented Stock Assessment Improvement Plan (SAIP) funds for a tagging project on the Canadian Grand Banks Northeast Distant Region of the Atlantic Ocean which resulted in estimated survival rates for this life stage. During 9 – 16 August 2011, 24 juvenile loggerheads from the Canadian Grand Banks Northeast Distant Region of the Atlantic Ocean were outfitted with pop-off archival transmitting tags (PATs). After a year, the tags popped off the animals and then transmitted their data. These transmission data were used in a known fate model and resulted in an estimated annual survival rate of 0.89 (95% confidence interval 0.72 – 0.96). The best model of the data suggested survival was constant across months.

BACKGOUND AND OBJECTIVES

Understanding the mortality of the various life history stages of sea turtles is important when developing population assessments. This is especially so for the pelagic stage of juvenile loggerhead turtles (*Caretta caretta*), for which little such information is available. Improved survival rates of oceanic juveniles will allow the National Marine Fisheries Service (NMFS) to better predict the recruitment of juvenile loggerhead turtles to the neritic coastal habitat from the oceanic habitat, where the neritic habitat is the region that was surveyed during the NMFS aerial abundance surveys.

The 2010 AMAPPS funds supplemented NMFS Stock Assessment Improvement Plan (SAIP) funds for a tagging study on the Canadian Grand Banks Northeast Distant Region of the Atlantic Ocean to determine survival rates of oceanic juveniles (NEFSC & SEFSC 2011). This study was not completed in 2010 due to weather conditions on the Grand Banks. The field work was successfully completed in summer 2011. Results are reported here.

METHODS

During the summer of 2011, the *F/V Eagle Eye II*, a commercial longliner, was contracted to deploy up to 50 satellite tags on loggerhead turtles ≥ 30 cm straight carapace length (SCL) in the Canadian Grand Banks Northeast Distant Region of the Atlantic Ocean (Figure I1). They searched on relatively calm days in warm waters (≥ 21°C = 70˚F) and along oceanographic fronts where loggerheads are known to congregate. Each day's search was at least 8 hours in duration. Once turtles were sighted, an inflatable boat was launched with the captain (or their designee) and a crew member aboard to pursue the loggerhead. Turtles were dip netted or captured by hand from the surface, placed in the inflatable boat, and ferried to the fishing vessel where pop-off archival transmitting tags were attached. The study was to end once five (5) days of searching had been expended or up to 50 turtles ≥ 30 cm SCL had been captured, whichever occurred first.

The tags were programmed to pop-off after one year (summer 2012) and then transmit their data. These data were then analyzed to estimate survival rates for this life stage of loggerheads.

RESULTS

During 9 – 16 August 2011, 24 juvenile loggerheads, that were 45 – 60 cm SCL, were captured via dip-net and pop-off archival transmitting tags (PATs) were attached to their carapaces. PATs popped off one year later (Figure I1).

The transmission data from the PATs were used in a known fate model in Program MARK (White and Burnham 1999) to estimate an annual survival rate of 0.89 (95% CI 0.72 – 0.96). The best model of the data suggested survival was constant across months.

ACKNOWLEDGEMENTS

Most of the funding for the data collection and analyses in this project was provided by the NMFS Stock Assessment Improvement Plan (SAIP) funds. The 2010 AMAPPS funds supplemented the SAIP funds and were used to complete the field work the following year from the SAIP project as not all PAT tags were able to be deployed in the single field season funded by SAIP.

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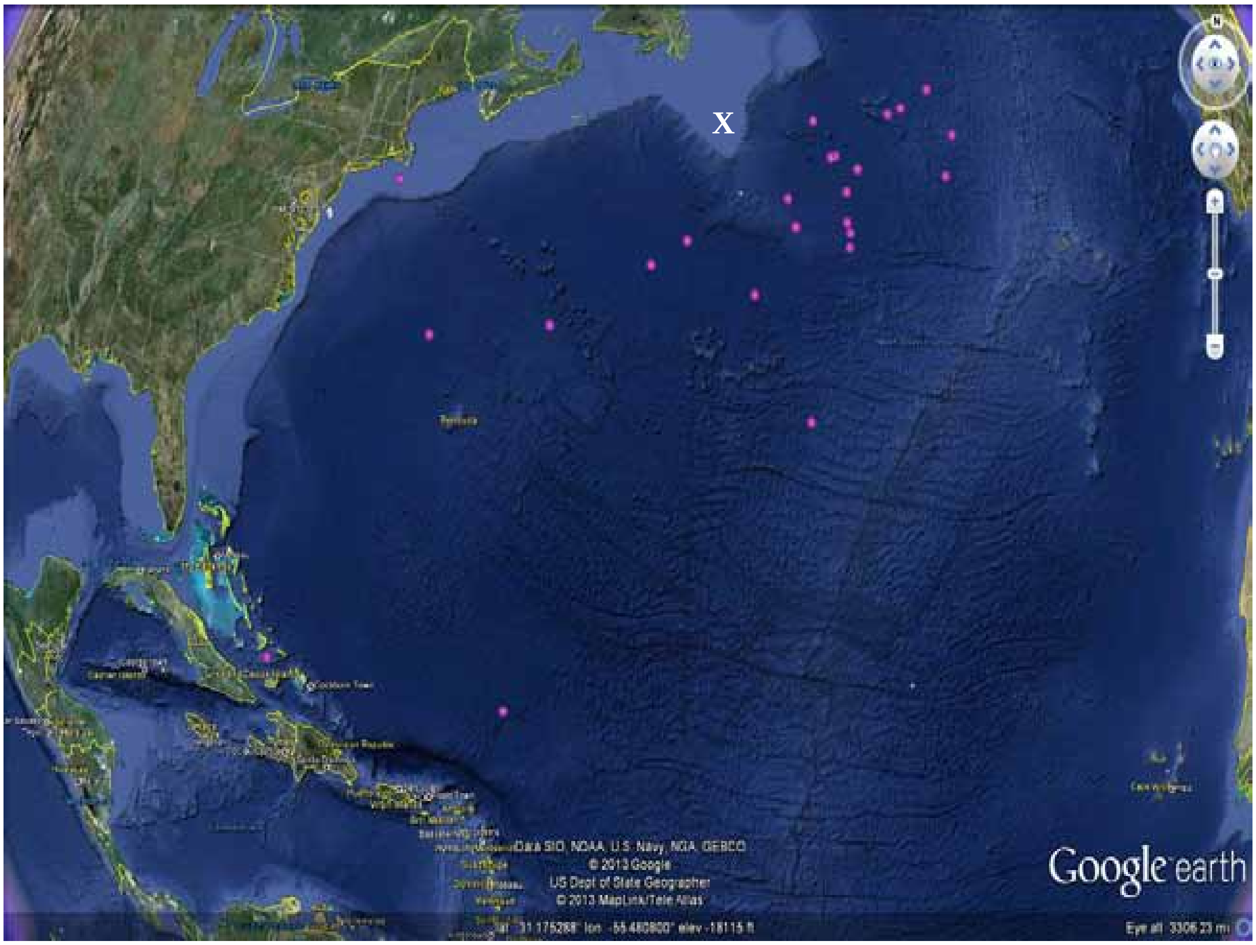
Figure I1. General initial location pop-off archival transmitting tags (PATs) were deployed during August 2011 (white X) and final locations of the PATs when they pop-off a year later (purple circles •).



Appendix J: *Development of an Oracle database to store the data collected on the AMAPPS surveys: Northeast Fisheries Science Center*

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SUMMARY

To achieve the AMAPPS objective of quantifying abundance and spatial distribution, a database is needed to store the collected data. The NEFSC had already created an Oracle database for some of the past NEFSC line-transect abundance surveys. During 2012, this database was expanded to be more flexible to incorporate data from disparate sources and in varying formats. In particular, the NEFSC and SEFSC strip-transect shipboard seabird data were added to the Oracle database. In addition, some of the environmental data collected by the ship (stored in another Oracle database) has been linked to the AMAPPS abundance survey database to obtain the time-specific values of the environmental variables associated with an AMAPPS survey event. The ability to download the Oracle data was also improved and used to output 2007 seabird data to be used in a community analysis being conducted by a University of Massachusetts student.

BACKGROUND AND OBJECTIVES

One of the objectives of the AMAPPS initiative is to quantify abundance and spatial distribution and to produce spatially-explicit density distribution maps that incorporate habitat characteristics. To do this a database needs to be developed to store the data collected. Ideally some of the features of the database include:

1) a common structure to store data that are from different species which are collected by different methods (Table J1);
2) a flexible structure to easily allow new data to be added;
3) a flexible structure to integrate the data collected from previous NMFS surveys and perhaps from surveys conducted by other investigators;
4) storing both the validated raw data and processed data which would be more directly used in future analyses;
5) storing or linking the collected above data to associated habitat characteristics;
6) include the associated meta data which describes the details needed to understand the data;
7) the ability to output data and summaries of the data
8) the ability to interface with a website that has GIS-like capabilities to output portions of the data, to display spatially explicit density distribution maps that incorporate habitat characteristics, and to produce user-specified temporally and spatially explicit density distribution maps.

2012 ACTIVITIES

The NEFSC had already created an Oracle database for some of the past NEFSC line-transect abundance surveys. During 2012, this database was expanded to be more flexible to incorporate data from disparate sources and in varying formats. For example, during 2012 the following aspects of the database were worked on:

- The database was expanded to include the strip-transect 2011 seabird data collected on the NEFSC and SEFSC 2011 shipboard surveys. These data and the NEFSC's 2007 seabird shipboard survey were validated and organized. The rest of the seabird datasets are currently being prepared for export to the Seabird Compendium. Metadata is being developed to document collection procedures.

- Tables in the Oracle database have been developed to store some of the NEFSC and SEFSC ship-collected environmental data (including data such as SST). These have been linked to the AMAPPS Oracle sightings and effort tables to allow a user to obtain the environmental data associated with the time and location of an AMAPPS event, such as time of a sighting or time the visual observers started searching.

- Development of SQL procedures and functions that can be used in the Oracle environment has been initiated to automate tasks such as segmenting tracklines according to effort status or environment, as well as calculating lengths and assigning environmental variables to segments.

- Investigations have been initiated to expand the NEFSC shipboard line-transect data tables to include the variables collected by the SEFSC. The 2011 summer shipboard line-transect data collected by the SEFSC were inputted into the database.

- The AMAPPS database was queried to output the 2007 seabird sighting and effort data which were provided to modelers at the University of Massachusetts who are planning to develop community based models taking into account spatial autocorrelation of the 2007 Gulf of Maine marine mammals, seabirds, zooplankton, and physical oceanography.

- An ArcMap geodatabase structure was initiated to store components used in the mapping of many of the datasets, and also to enable spatial linking of some variables such as bathymetry and satellite-derived SST, etc.

- The existing NEFSC tissue tracking database was utilized to monitor disposition and handling of tissue samples collected during AMAPPS research.

- The data collected from the satellite-tagged loggerhead turtles was also stored in an Oracle database. Weekly automatic downloads of these data from Argos into NEFSC-housed tables facilitates regular updates of the interactive Google Earth interface that has been developed by NEFSC staff for the NEFSC Protected Species Branch website. This website can be viewed at: http://www.nefsc.noaa.gov/psb/turtles/turtleTracks.html. See Figure J1 for a screenshot of this webpage.

- Passive acoustic data collected on AMAPPS surveys were stored on NEFSC servers. Developing integration between the acoustic datasets and the sighting and environmental data is a goal for the coming year.

- Harbor seal aerial photograph metadata and associated counts from the 2011/2012 abundance surveys have been added to the Oracle database.

ACKNOWLEDGEMENTS
The databases were originally developed and funded by the NEFSC. During 2012 updates of the database to incorporate the AMAPPS data were funded by the Bureau of Ocean Energy Management (BOEM) and the US Navy through two Interagency Agreements for the AMAPPS project.

Table J1. Types of data that are or could be included in or linked to the AMAPPS database, including the platform the data are collected from, the target species, and the uses of these data in the final products.

			Final products		
Data types (examples of variables)	Collection platform	Target species	Distribution or abundance	Habitat models	Other
Line transect data (species, distance to group, group size, possible covariates such as weather and sightability conditions, effort)	ship, plane	cetaceans, seals, turtles	Y	Y	
Passive acoustic data (detections, effort)	ship	cetaceans	Y	Y	
Plankton data (via bongo nets, VPR, EK60, ME70)	ship	plankton		Y	
Strip transect data (species, distance category, group size, possible covariates, effort)	ship, plane	seabirds	Y	Y	
Physical characteristics (bottom depth and slope; water temperature, salinity and chlorophyll; current speed)	ship, satellite	none	Y	Y	Derive other characteristics such as thermocline and locations and intensities
Photo-ids	ship, plane	cetaceans, seals, turtles, seabirds	Y		Confirm species ID and assist in determining stock structure
Biopsies (location of tag placement, movements, resident time, depth profile)	ship	cetaceans			Determine stock structure and archive tissues that could be used in pollution and other biological analyses
Tag data (location of tag placement, movements, resident time, depth profile)	ship, land	turtles, seals, seabirds	Y	Y	Provide some life history characteristics
Haul out count data (location, number of adults and pups)	plane	seals	Y	Y	

Figure J1: Screenshot of interactive webpage displaying positions of satellite-tagged loggerhead turtles.